(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 539 641 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
16.04.2025 Bulletin 2025/16

(21) Application number: **23824209.3**

(22) Date of filing: **13.06.2023**

(51) International Patent Classification (IPC):
H10K 50/11 $^{(2023.01)}$ ***H10K 50/15*** $^{(2023.01)}$
H10K 50/16 $^{(2023.01)}$ ***H10K 85/60*** $^{(2023.01)}$

(52) Cooperative Patent Classification (CPC):
H10K 50/00; H10K 50/11; H10K 50/15;
H10K 50/16; H10K 85/60; H10K 99/00

(86) International application number:
PCT/KR2023/008131

(87) International publication number:
WO 2023/243995 (21.12.2023 Gazette 2023/51)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **13.06.2022 KR 20220071683**

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(54) PELLET FOR ORGANIC ELECTROLUMINESCENT DEVICE AND ORGANIC ELECTROLUMINESCENT DEVICE USING SAME

(57) The present invention relates to a pellet for an organic electroluminescent device and an organic electroluminescent device using same. The pellet for an organic electroluminescent device is prepared by compressing at least two kinds of organic compound powders containing a first organic compound powder and a second organic compound powder, wherein the pellet has the same maximum emission wavelength as the organic compound having the longer emission wavelength among the first and second organic compounds.

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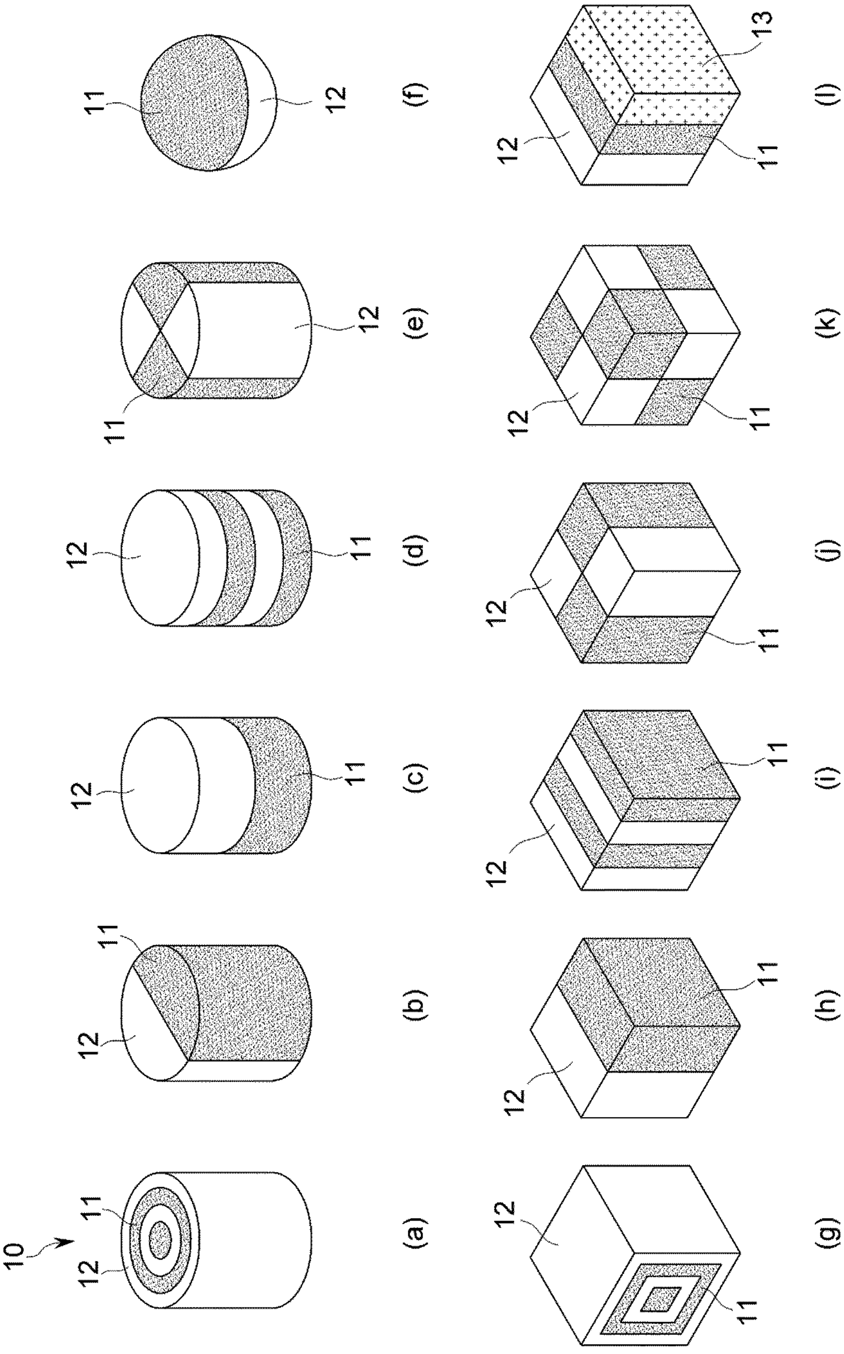
[FIG. 1]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Description

Technical Field

[0001] The present invention relates to a pellet for an organic electroluminescent (EL) device and an organic electroluminescent device using same.

Background Art

[0002] An organic electroluminescent device (hereinafter referred to as "organic EL device") operates by applying a voltage between two electrodes, wherein holes are injected from the anode and electrons are injected from the cathode into the organic layer. The injected holes and electrons combine with each other, forming excitons, and light is emitted as the excitons transition to the ground state. Based on the functions thereof, the organic materials used in the organic layer can be classified into light-emitting materials, hole-injection materials, hole-transport materials, electron-transport materials, electron-injection materials, and so on.

[0003] To improve the performance of such organic EL devices, particularly in terms of lifespan, efficiency, and driving voltage, the organic layer is made of multiple organic compounds, for example, at least one host material having a dopant dispersed therein. The organic layer is formed by evaporating each of the organic compounds individually. Controlling the deposition rate of each organic compound with precision was difficult, and it led to relative waste in terms of material utilization. Additionally, as organic compounds often take the form of powders and can become electrostatically charged, handling them during deposition posed challenges.

Disclosure of Invention

Technical Problem

[0004] The present invention aims to provide a pellet that not only exhibits excellent thermal and chemical stability but also has low surface resistance and a small specific surface area, enabling the implementation of a high-efficiency and long-lifespan organic electroluminescent (EL) device.

Solution to Problem

[0005] To achieve the goal, the present invention provides a pellet for an organic EL device, which comprises two or more types of organic compound powders, including a first organic compound powder and a second organic compound powder that have been compressed, wherein the pellet has the same maximum emission wavelength as the organic compound with a longer emission wavelength among the first organic compound and the second organic compound.

[0006] The pellet of the present invention may have the same maximum emission wavelength as the mixture of the first organic compound powder and the second organic compound powder.

[0007] The pellet of the present invention may include a first region having a first organic compound powder compressed therein, and a second region having second organic compound powder compressed therein and integrated with the first region.

[0008] The pellet of the present invention may have the first and second regions alternately arranged in a radial direction from the center outward.

[0009] The pellet of the present invention may have the first and second regions arranged in a longitudinal direction. In this regard, the first and second regions may be arranged in an alternating pattern.

[0010] The pellet of the present invention may have the first and second regions alternately arranged in a circumferential direction. In this regard, the first and second regions may be alternately arranged in an upper and lower configuration.

[0011] The pellet of the present invention may have a shape selected from the group consisting of polyhedral, cylindrical, and spherical shapes.

[0012] In the pellet of the present invention, the first and second organic compound powders may be included at a weight ratio of 1:99 to 99:1.

[0013] In the pellet of the present invention, both the first and second organic compound powders may be sublimable powders.

[0014] In the pellet of the present invention, the first and second organic compound powders may have a deposition temperature difference of 0 to 30°C under a pressure of 10^{-6} torr.

[0015] In the pellet of the present invention, the first organic compound may be a hole-transporting organic compound, and the second organic compound may be an electron-transporting organic compound. In this regard, the hole-transporting organic compound may be a hole-transporting host, which may be a carbazole-based compound. The electron-transporting organic compound may be an electron-transporting host, which may be an azine-based compound.

[0016] The pellet of the present invention may be a molded body formed by injection molding under a pressure of 20,000 to 40,000 kgf/cm^2 to the two or more organic compound powders, without heat treatment.

[0017] The pellet of the present invention may have a BET specific surface area smaller than that of the simple mixture of the first and second organic compound powders.

[0018] The pellet of the present invention may have a surface resistance smaller than that of the simple mixture of the first and second organic compound powders.

[0019] The present invention provides an organic electroluminescent device including: an anode; a cathode; and at least one organic layer interposed between the anode and cathode, wherein at least one of the organic layers is a homogeneous thin film containing the first and second organic compounds formed using the pellet.

Advantageous Effects of Invention

[0020] The pellet according to the present invention not only exhibits excellent thermal and chemical stability but also has low surface resistance, a small specific surface area, and superior reproducibility and uniformity of the thin film, thereby enabling the implementation of a high-efficiency and long-lifespan organic EL device.

Brief Description of Drawings

[0021]

FIG. 1 shows schematic perspective views of shapes of the pellets according to the present invention.

FIG. 2 is a schematic cross-sectional view of an organic electroluminescent device according to the first embodiment of the present invention.

FIG. 3 is a schematic cross-sectional view of an organic electroluminescent device according to the second embodiment of the present invention.

FIG. 4 is a schematic cross-sectional view of an organic electroluminescent device according to the third embodiment of the present invention.

<Description of Reference Numerals>

[0022]

10: Pellet, 11: First region
12: Second region, 13: Third region
100: Anode, 200: Cathode
300: Organic layer, 310: Hole injection layer
320: Hole transport layer, 330: Emission layer
340: Electron transport layer, 350: Electron injection layer
360: Electron transport auxiliary layer

Best Mode for Carrying out the Invention

[0023] Hereinafter, Hereinafter, a detailed description will be given of the present invention.

[0024] All terms (including technical and scientific terms) used in this specification may be interpreted as having the meaning commonly understood by those skilled in the art to which the present invention pertains, unless otherwise defined. Additionally, terms defined in generally used dictionaries should not be interpreted ideally or overly, unless explicitly defined otherwise.

[0025] Throughout the specification, when a certain part "includes" a certain component, it is understood that this is an open-ended term that allows the inclusion of other components, unless explicitly stated otherwise.

[0026] Also, throughout the specification, terms such as "on" or "above" should be interpreted to include not only cases where a part is directly above or below a target part, but also cases where there is another part in between, and it does not necessarily imply a direction based on gravity.

[0027] Furthermore, in this specification, terms such as "first" and "second" are used to distinguish components from each other, not to indicate any particular order or importance.

<Pellet for Organic Electroluminescent Device>

[0028] The present invention provides a pellet for forming an organic layer (e.g., an emission layer) of an organic electroluminescent (EL) device.

[0029] The pellet according to the present invention is a molded body wherein two or more types of organic compound powders including a first organic compound powder and a second organic compound powder are compressed, and the pellet has a maximum emission wavelength equal to that of the organic compound with the longer emission wavelength between the first and second organic compounds.

[0030] Specifically, in the pellet of the present invention, the first organic compound powder and the second organic compound powder are simply mixed and compressed without heat treatment and thus densified without undergoing any chemical changes. Thus, the pellet of the present invention is manufactured without any chemical changes in the first and second organic compound powders. Therefore, the maximum emission wavelength of the pellet is the same as the maximum emission wavelength of the organic compound with the longer emission wavelength among the first and second organic compounds, and it is also same as the maximum emission wavelength of the simple mixture of the first and second organic compound powders. Furthermore, the pellet of the present invention has a BET specific surface area smaller than that of the simple mixture of the first and second organic compound powders. As a result, the pellet of the present invention has a small surface area exposed to air, providing superior chemical resistance and thermal stability. Additionally, because being lower in surface resistance than the simple mixture of the first and second organic compound powders, the pellet according to the present invention generates less static electricity and is easier to handle. Hence, the pellet can improve the processability of deposition during the fabrication of the device. The pellet of the present invention is not only easy to store and handle but can also be designed in various shapes as desired. Moreover, the pellet of the present invention can be used as a single evaporation source, allowing for easy control of the deposition rate, which simplifies the deposition process and reduces manufacturing costs. Furthermore, when forming an organic layer of an organic EL device using the pellet of the present invention, a homogeneous thin film can be formed, where the first and second organic compounds are uniformly mixed, as opposed to using the first and second organic compound powders separately or in a simple mixed state. Thus, the pellet enables the implementation of a high-efficiency and long-lifespan organic EL device. Additionally, the pellet of the present invention exhibits excellent reproducibility of thin films during continuous processes such as roll-to-roll manufacturing, allowing the continuous production of organic EL devices.

[0031] In the pellet of the present invention, both the first and second organic compound powders are solid at room temperature and sublimable. As a result, the pellet of the present invention can easily be formed into a homogeneous thin film using dry film-forming methods such as vacuum deposition.

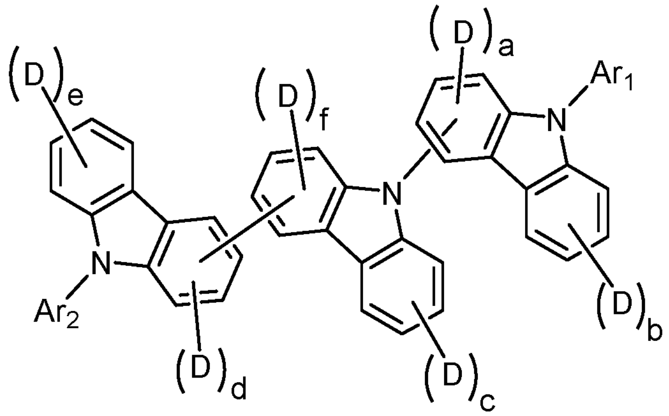
[0032] For example, the first and second organic compound powders may have a sublimation temperature difference of approximately 0 to 30°C under a pressure of 10^{-6} torr. Thus, the first and second organic compound powders may have a deposition temperature difference of approximately 0 to 30°C under a pressure of 10^{-6} torr. In this context, the pellet of the present invention can be deposited while maintaining the set mixing ratio.

[0033] The first organic compound usable in the present invention is not particularly limited, as long as it is a hole-transporting organic compound with stronger hole-transporting properties than the second organic compound.

[0034] The hole-transporting organic compound may be a hole-transporting host. For example, the hole-transporting host may be a carbazole-based compound.

[0035] Specifically, examples of the hole-transporting organic compound include, but are not limited to, compounds represented by Chemical Formula 1:

[Chemical Formula 1]



wherein,

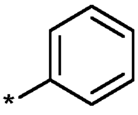
D represents a deuterium atom,
a, d, and f are each an integer of 0 to 3,
b, c, and e are each an integer of 0 to 4,
Ar_1 and Ar_2, which are same or different, may each be independently selected from the group consisting of a hydrogen atom, a deuterium atom (D), a halogen group, a cyano group, a nitro group, an amino group, an alkyl group of C_1-C_{40}, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40}, a heterocycloalkyl group having 3 to 40 nuclear atoms, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of C_1-C_{40}, an arylboron group of C_6-C_{60}, a phosphine oxide group, an alkylphosphine oxide group of C_1-C_{40}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}, or may form a fused ring with an adjacent group,
the alkyl group, alkenyl group, alkynyl group, cycloalkyl group, heterocycloalkyl group, aryl group, heteroaryl group, alkyloxy group, aryloxy group, alkylsilyl group, arylsilyl group, alkylboron group, arylboron group, alkylphosphine oxide group, arylphosphine group, arylphosphine oxide group, arylamine group and fused ring of Ar_1 and Ar_2 may not or may each independently have one or more substituents selected from the group consisting of a deuterium atom, a halogen group, a cyano group, a nitro group, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40} a heterocycloalkyl group having 3 to 40 nuclear atoms, an alkyl group of C_1-C_{40}, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of C_1-C_{40}, an arylboron group of C_6-C_{60}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}, with a proviso that when there are two or more substituents, they may be same or different.

[0036] In the compound represented by Chemical Formula 1, a, d, and f are each an integer of 0 to 3, b, c, and e are each an integer of 0 to 4. Herein, given that a, b, c, d, e, and f are each 0, it is meant that none of the hydrogen atoms on the compound are substituted with deuterium (D). Given that a, d, and f are each an integer of 1 to 3 and b, c, and e are each an integer of 1 to 4, it is meant that one or more hydrogen atoms on the compound are substituted with deuterium (D). In this regard, there may be $13 \leq a+b+c+d+e+f \leq 21$. According to an embodiment, the number of deuterium atoms (D) contained in the compound of Chemical Formula 1 may be at least 13, or specifically at least 21. This compound of Chemical Formula 1 can enhance the stability of the chemical structure through deuterium (D) substitution, enabling the simultaneous realization of characteristics such as low voltage, high efficiency, and long lifespan of the organic electroluminescent device.

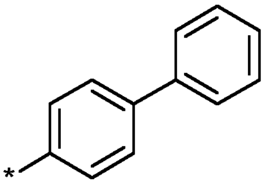
[0037] The deuterium may also be substituted with another substituent (R). When there are multiple substituents (R), they may be same or different. The other substituent (R) may be selected from the group consisting of a halogen group, a cyano group, a nitro group, an amino group, an alkyl group of C_1-C_{40}, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40}, a heterocycloalkyl group having 3 to 40 nuclear atoms, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of C_1-C_{40}, an arylboron group of C_6-C_{60}, a phosphine oxide group, an alkylphosphine oxide group of C_1-C_{40}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}.

[0038] In the compound represented by Chemical Formula 1, Ar_1 and Ar_2, which are same or different, may each be independently selected from the group consisting of a hydrogen atom, a deuterium atom (D), a halogen group, a cyano group, a nitro group, an amino group, an alkyl group of C_1-C_{40}, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40}, a heterocycloalkyl group having 3 to 40 nuclear atoms, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of C_1-C_{40}, an arylboron group of C_6-C_{60}, a phosphine oxide group, an alkylphosphine oxide group of C_1-C_{40}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}, or may form a fused ring with an adjacent group. Specifically, Ar_1 and Ar_2 are same or different and may each be independently selected from the group consisting of an aryl group of C_6-C_{60} and a heteroaryl group having 5 to 60 nuclear atoms.

[0039] In an embodiment, Ar_1 and Ar_2 are same or different and may each be a substituent independently selected from the group consisting of the following substituents S1 to S4:



S1



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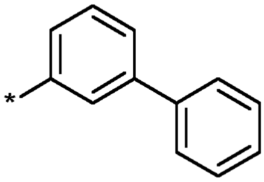

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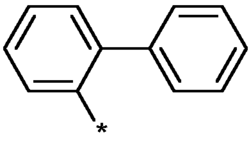
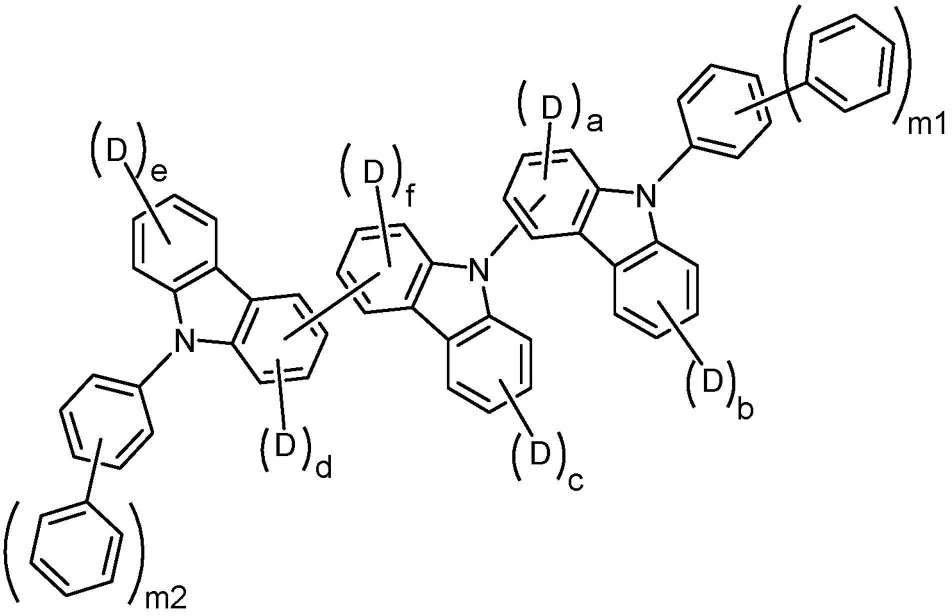


S4

wherein, * represents a bonding site to Chemical Formula 1.

[0040] Depending on Ar_1 and Ar_2, the compound of Chemical Formula 1 may be a compound represented by Chemical Formula 2, but with no limitations thereto:

[Chemical Formula 2]

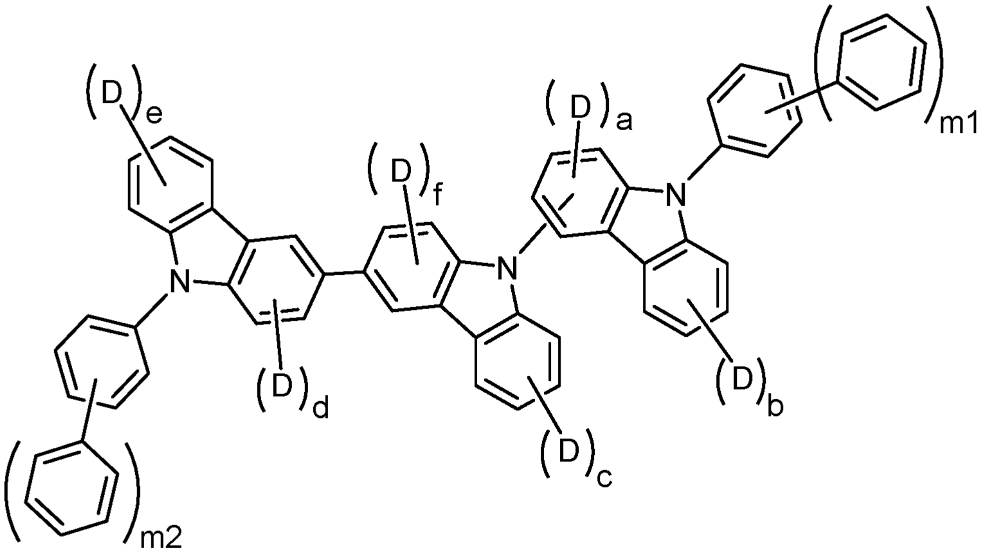


wherein,

a, b, c, d, e, and f are each as defined in Chemical Formula 1,
m1 and m2 are each 0 or 1.

[0041] In addition, the compound represented by Chemical Formula 1 may have various structures depending on the linkage positions between the carbazole moieties. In an embodiment, the compound of Chemical Formula 1 may be the compound represented by the following Chemical Formula 3:

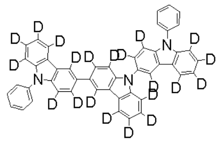
[Chemical Formula 3]



wherein,

a, b, c, d, e, and f are each as defined in Chemical Formula 1, and
m1 and m2 are each 0 or 1.

[0042] The compound represented by Chemical Formula 1 according to the present invention may be further specified as the following exemplary compounds, for example, compounds A-1 to D-4, but is not limited thereto:



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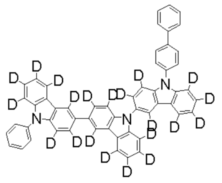

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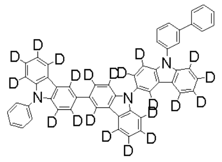

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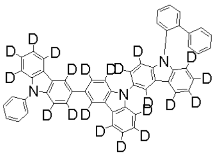

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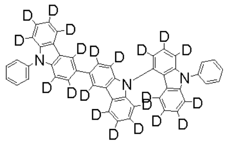

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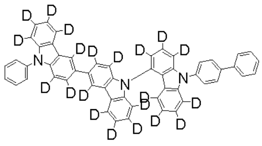

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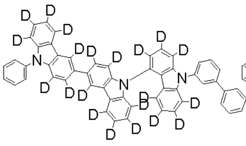

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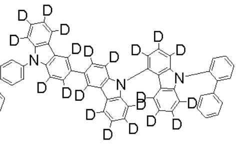

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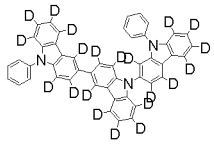

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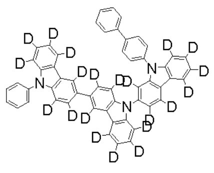

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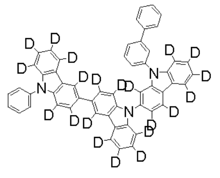

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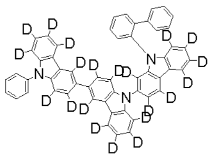

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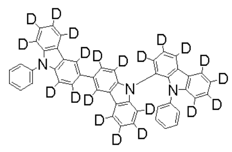

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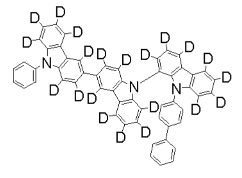

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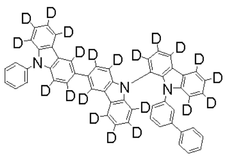

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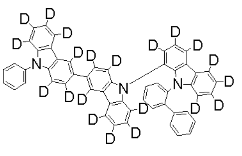

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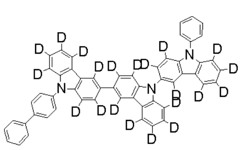
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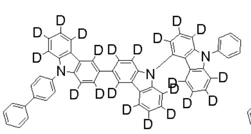
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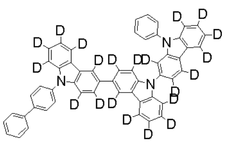
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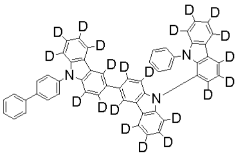
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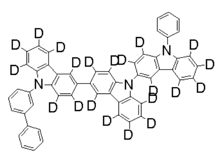
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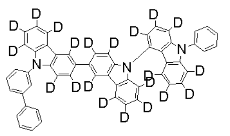
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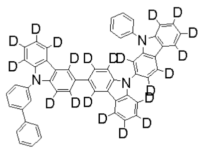
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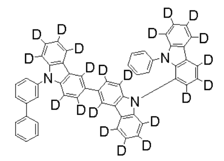
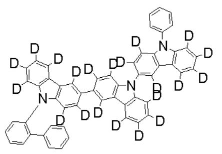
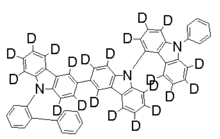

C-4


D-1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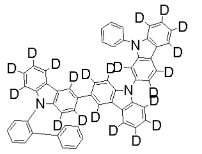
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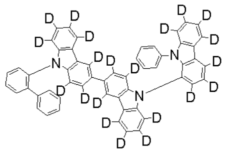
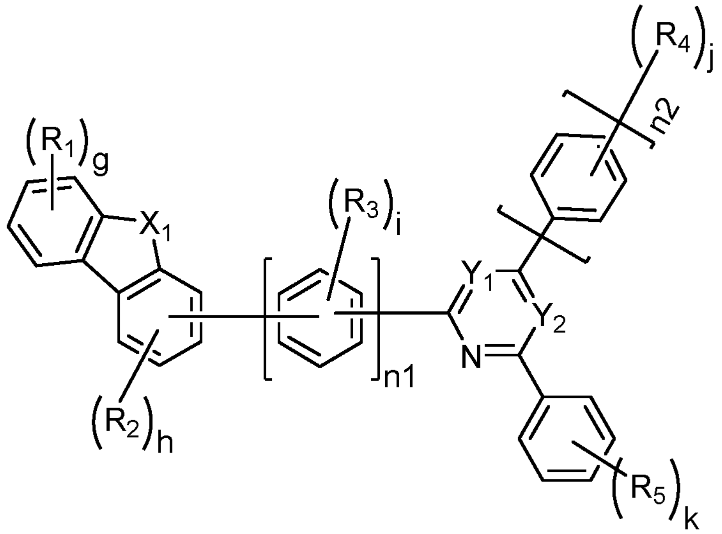

D-4

[0043] The second organic compound available in the present invention is not particularly limited as long as it is an electron-transporting organic compound with stronger electron-transporting properties than the first organic compound.

[0044] The electron-transporting organic compound may be an electron-transporting host. In an embodiment, the electron-transporting host may be an azine-based compound including a triazine group, a pyridine group, a pyrimidine group, or the like.

[0045] Specifically, the electron-transporting organic compound may be a compound represented by Chemical Formula 4, but is not limited thereto:

[Chemical Formula 4]



wherein,

h is an integer of 0 to 3,
g and i are each an integer of 0 to 4,
j and k are each an integer of 0 to 5,
n1 is an integer of 1 to 5,
n2 is an integer of 0 or 1,
X_1 is selected from the group consisting of O, S, Se, N(Ar_3), C(Ar_4)(Ar_5), and Si(Ar_6)(Ar_7),
Y_1 and Y_2, which are same or different, are each independently N or C(Ar_8), with a proviso that at least one of Y_1 and Y_2

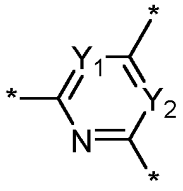
is N,

Ar_3 to Ar_8 and R_1 to R_5, which are same or different, are each independently selected from the group consisting of a hydrogen atom, a deuterium atom (D), a halogen group, a cyano group, a nitro group, an amino group, an alkyl group of C_1-C_{40}, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40}, a heterocycloalkyl group having 3 to 40 nuclear atoms, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of C_1-C_{40}, an arylboron group of C_6-C_{60}, a phosphine oxide group, an alkylphosphine oxide group of C_1-C_{40}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}, or may form a fused ring with an adjacent group, and

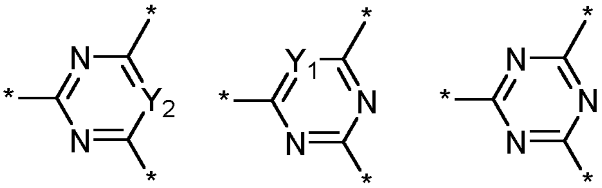
the alkyl group, alkenyl group, alkynyl group, cycloalkyl group, heterocycloalkyl group, aryl group, heteroaryl group, alkyloxy group, aryloxy group, alkylsilyl group, arylsilyl group, alkylboron group, arylboron group, alkylphosphine oxide group, arylphosphine group, arylphosphine oxide group, arylamine group and fused ring of Ar_3 to Ar_8 and R_1 to R_5 may not or may each independently have one or more substituents selected from the group consisting of a deuterium atom, a halogen group, a cyano group, a nitro group, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40}, a heterocycloalkyl group having 3 to 40 nuclear atoms, an alkyl group of C_1-C_{40}, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of C_1-C_{40}, an arylboron group of C_6-C_{60}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}, with a proviso that when there are two or more substituents, they may be same or different.

[0046] In the compound represented by Chemical Formula 4, Y_1 and Y_2, which are same or different, are each independently N or $C(Ar_8)$, with a proviso that at least one of Y_1 and Y_2 is N.

[0047] Depending on Y_1 and Y_2, the moiety



in the compound represented by Chemical Formula 4 may be selected from the group consisting of the following moieties Mo-1 to Mo-3:



Mo-1 Mo-2 Mo-3

wherein,

* is a bonding site to Chemical Formula 4,
Y_1 and Y_2 are each independently $C(Ar_8)$, and
Ar_8 is as defined in Chemical Formula 4.

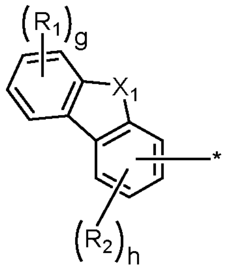
[0048] In the compound represented by Chemical Formula 4, n1 is an integer of 1 to 5, and n2 is 0 or 1. In an embodiment, n1 may be 1 or 2 and n2 may be 0 or 1. In Chemical Formula 4, when n2 is 0, j is 1.

[0049] In the compound represented by Chemical Formula 4, X_1 is selected from the group consisting of O, S, Se, $N(Ar_3)$, $C(Ar_4)(Ar_5)$, and $Si(Ar_6)(Ar_7)$. Depending on X_1, the dibenzo moiety may be a monovalent dibenzofuran group, a monovalent dibenzothiphene group, a monovalent fluorene group, etc.

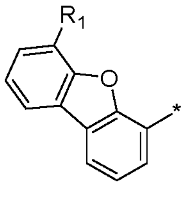
[0050] Ar_3 to Ar_8, which are same or different, may each be independently selected from the group consisting of a hydrogen atom, a deuterium atom (D), a halogen group, a cyano group, a nitro group, an amino group, an alkyl group of C_1-C_{40}, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40}, a heterocycloalkyl group having 3 to 40 nuclear atoms, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of

C_1-C_{40}, an arylboron group of C_6-C_{60}, a phosphine oxide group, an alkylphosphine oxide group of C_1-C_{40}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}, or may form a fused ring with an adjacent group (e.g., Ar_3-R_1, Ar_3-R_2, Ar_4-Ar_5, Ar_6-Ar_7, Ar_4-R_1, Ar_4-R_2, Ar_6-R_1, Ar_6-R_2, etc.). Specifically, Ar_3 to Ar_8, which are same or different, may each be independently selected from the group consisting of an alkyl group of C_1-C_{40}, an aryl group of C_6-C_{60} and a heteroaryl group having 5 to 60 nuclear atoms and may form a fused ring with an adjacent group (e.g., Ar_3-R_1, Ar_3-R_2, Ar_4-Ar_5, Ar_6-Ar_7, Ar_4-R_1, Ar_4-R_2, Ar_6-R_1, Ar_6-R_2, etc.). Here, the fused ring may be at least one selected from the group consisting of a fused aliphatic ring of C_3-C_{60} (specifically, a fused aliphatic ring of C_3-C_{30}), a fused aromatic ring of C_6-C_{60} (specifically, a fused aromatic ring of C_6-C_{30}), a 5- to 60-membered fused heteroaromatic ring (specifically, 5-to 30-membered fused heteroaromatic ring), a spiro ring of C_3-C_{60}, and a combination thereof.

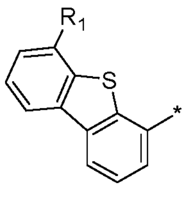
[0051] According to an embodiment, the moiety



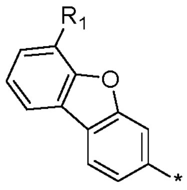
in Chemical Formula 4 may be selected from the group consisting of the following moieties Dz-1 to Dz-32, but with no limitations thereto:



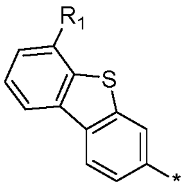
Dz-1



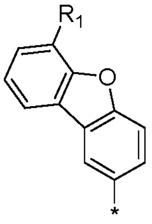
Dz-2



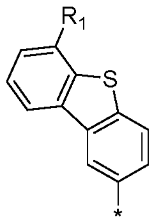
Dz-3



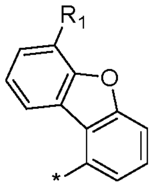
Dz-4



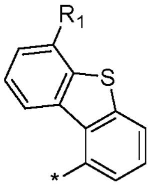
Dz-5



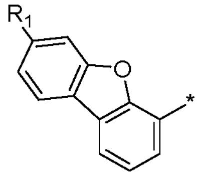
Dz-6



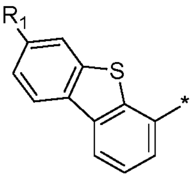
Dz-7



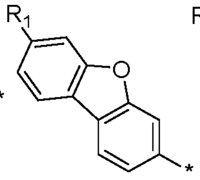
Dz-8



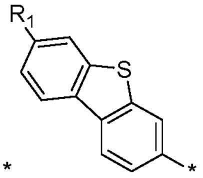
Dz-9



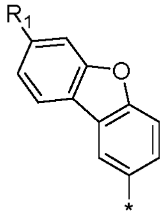
Dz-10

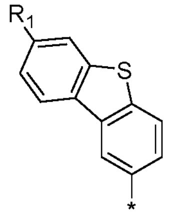


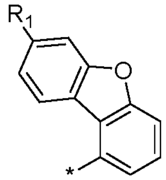
Dz-11

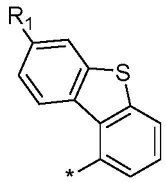


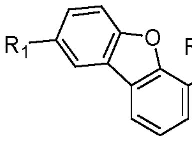
Dz-12


Dz-13


Dz-14


Dz-15


Dz-16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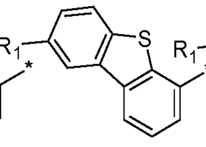
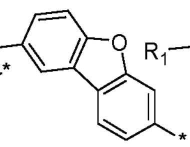
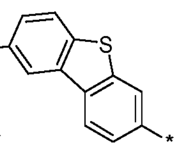
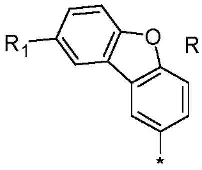
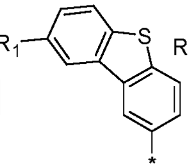
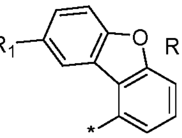

Dz-18

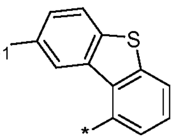

Dz-19

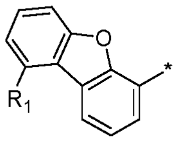

Dz-20

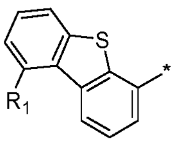

Dz-21

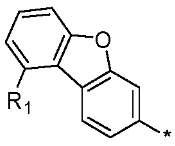

Dz-22


Dz-23


Dz-24


Dz-25


Dz-26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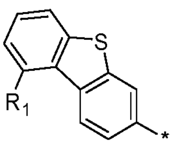
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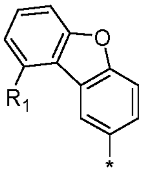
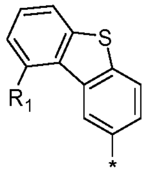
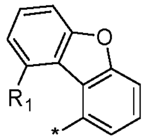
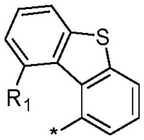

Dz-29


Dz-30


Dz-31


Dz-32

wherein,

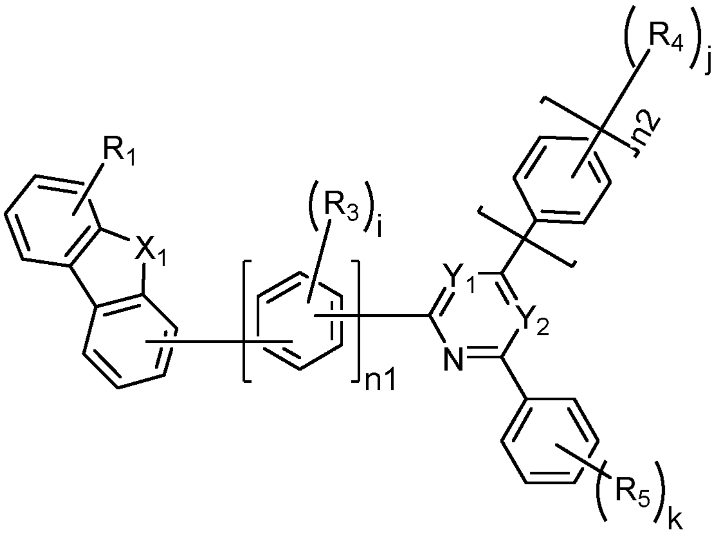
* is a bonding site to Chemical Formula 4, and
R_1 may be an aryl group of C_6-C_{60}, and specifically a phenyl.

[0052] In the compound represented by Chemical Formula 4, h is an integer of 0 to 3, g and i are each an integer of 0 to 4, and j and k are each an integer of 0 to 5. Here, given that g, h, i, j, and k are each 0, it is meant that none of the hydrogen atoms on the compound are substituted with deuterium (D). When h is an integer of 1 to 3, g and i are each an integer of 1 to 4, and j and k are each an integer of 1 to 5, one or more R_1 to R_5, which are same or different, may each independently selected from the group consisting of a deuterium atom (D), a halogen group, a cyano group, a nitro group, an amino group, an alkyl group of C_1-C_{40}, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40}, a heterocycloalkyl group having 3 to 40 nuclear atoms, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of C_1-C_{40}, an arylboron group of C_6-C_{60}, a phosphine oxide group, an alkylphosphine oxide group of C_1-C_{40}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}, or may form a fused ring with an adjacent group. Specifically, one or more R_1 to R_5, which are same or different, may each be independently selected from the group consisting of a hydrogen atom, a halogen group, a cyano group, a nitro group, an amino group, an alkyl group of C_1-C_{40}, an aryl group of C_6-C_{60}, and a heteroaryl group having 5 to 60 nuclear atoms.

[0053] The alkyl group, alkenyl group, alkynyl group, cycloalkyl group, heterocycloalkyl group, aryl group, heteroaryl group, alkyloxy group, aryloxy group, alkylsilyl group, arylsilyl group, alkylboron group, arylboron group, alkylphosphine oxide group, arylphosphine group, arylphosphine oxide group, and arylamine group and the fused ring of Ar_3 to Ar_8 and R_1 to R_5 may not or may each independently have at least one substituent selected from the group consisting of a deuterium atom, a halogen group, a cyano group, a nitro group, an alkenyl group of C_2-C_{40}, an alkynyl group of C_2-C_{40}, a cycloalkyl group of C_3-C_{40}, a heterocycloalkyl group having 3 to 40 nuclear atoms, an alkyl group of C_1-C_{40}, an aryl group of C_6-C_{60}, a heteroaryl group having 5 to 60 nuclear atoms, an alkyloxy group of C_1-C_{40}, an aryloxy group of C_6-C_{60}, an alkylsilyl group of C_1-C_{40}, an arylsilyl group of C_6-C_{60}, an alkylboron group of C_1-C_{40}, an arylboron group of C_6-C_{60}, an arylphosphine group of C_6-C_{60}, an arylphosphine oxide group of C_6-C_{60}, and an arylamine group of C_6-C_{60}. When there are two or more substituents, they are same or different.

[0054] The compound of Chemical Formula 4 may be a compound represented by the following Chemical Formula 5, but is not limited thereto:

[Chemical Formula 5]

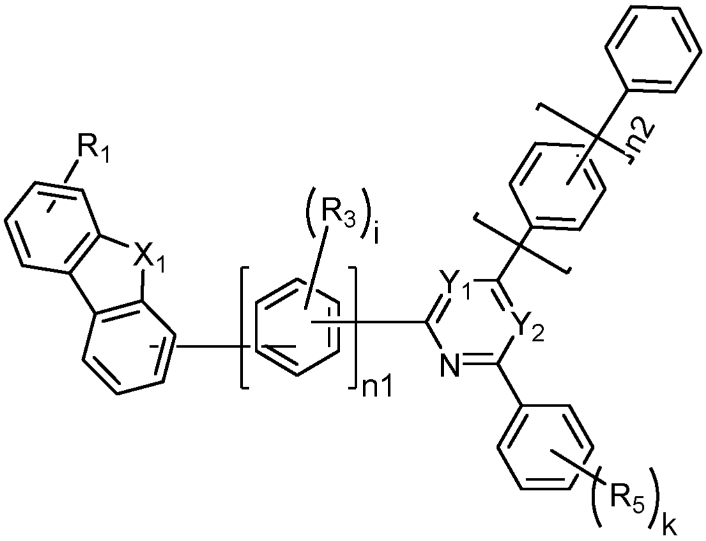


wherein,

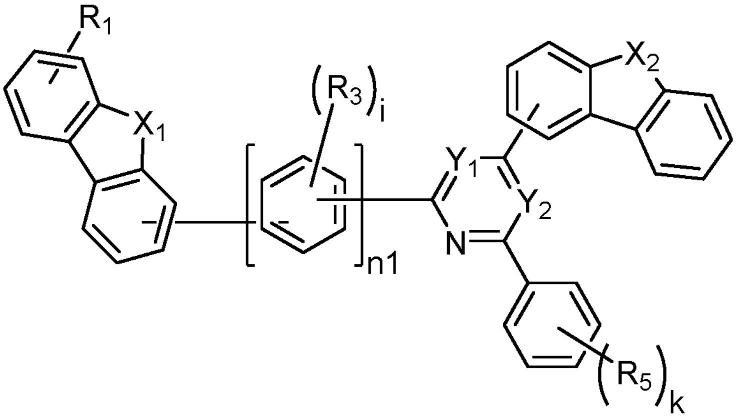
i, j, k, R_1, R_3 to R_5, n1, n2, X_1, Y_1, and Y_2 are each as defined in Chemical Formula 4.

[0055] Specifically, the compound of Chemical Formula 4 may be a compound represented by the following Chemical Formula 6 or 7, but with no limitations thereto:

[Chemical Formula 6]



[Chemical Formula 7]

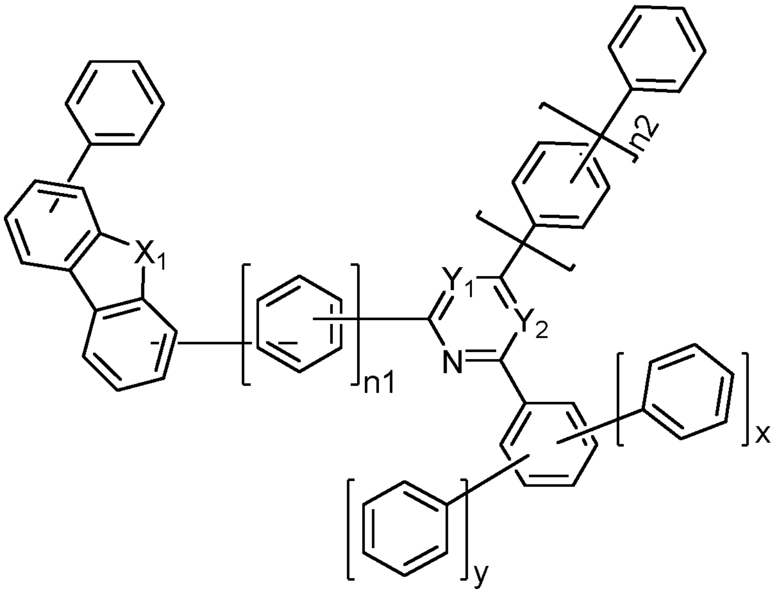


wherein,

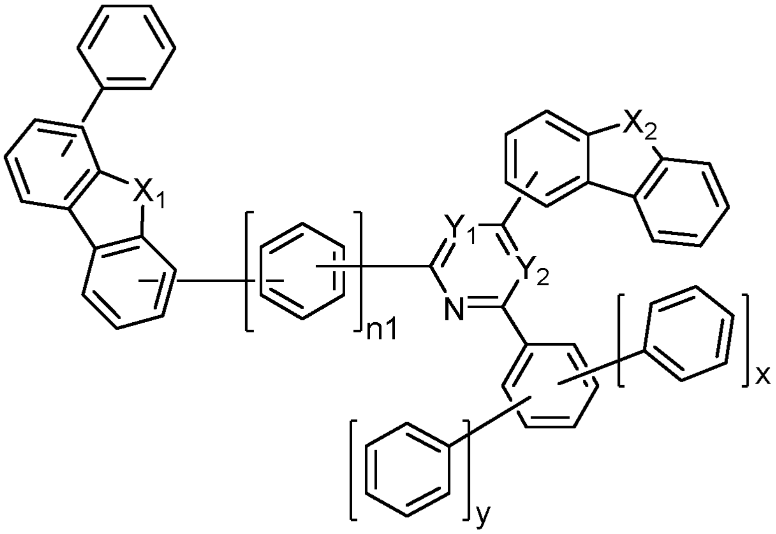
i, k, R_1, R_3, R_5, n1, n2, Y_1, and Y_2 are each as defined in Chemical Formula 4,
X_1 and X_2 may each be O or S and specifically O.

[0056] More specifically, the compound of Chemical Formula 4 may be a compound represented by the following Chemical Formula 8 or 9, but is not limited thereto:

[Chemical Formula 8]



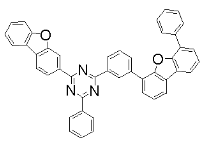
[Chemical Formula 9]



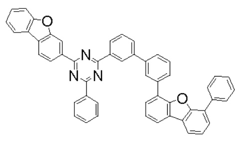
wherein,

n1, n2, Y_1, and Y_2 are each as defined in Chemical Formula 4, and specifically n1 is 1 or 2, n2 is 0 or 1, and Y_1 and Y_2 are both N,
x and y may each be 0 or 1,
X_1 and X_2 may each be O or S and specifically may be O.

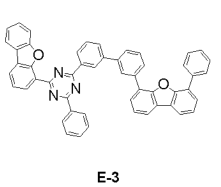
[0057] The compound represented by Chemical Formula 2 according to the present invention may be further specified as the following exemplary compounds, for example, compounds E-1 to E-10, but is not limited thereto:



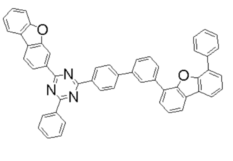
E-1



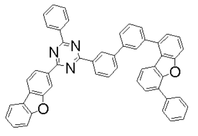
E-2



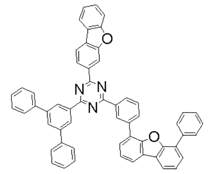
E-3



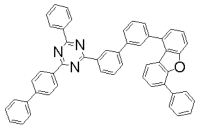
E-4



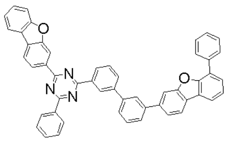
E-5



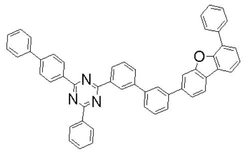
E-6



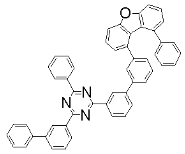
E-7



E-8



E-9



E-10

[0058] As used herein, the term "alkyl" refers to a monovalent substituent derived from a linear or branched saturated hydrocarbon having 1 to 40 carbon atoms. Examples include methyl, ethyl, propyl, isobutyl, sec-butyl, pentyl, isoamyl, hexyl, and the like, but are not limited thereto.

[0059] As used herein, the term "alkenyl" refers to a monovalent substituent derived from a linear or branched unsaturated hydrocarbon of 2 to 40 carbon atoms and containing at least one carbon-carbon double bond. Examples include vinyl, allyl, isopropenyl, 2-butenyl, and the like, but are not limited thereto.

[0060] As used herein, the term, "alkynyl" refers to a monovalent substituent derived from a linear or branched unsaturated hydrocarbon of 2 to 40 carbon atoms and containing at least one carbon-carbon triple bond. Examples include ethynyl, 2-propynyl, and the like, but are not limited thereto.

[0061] As used herein, the term "cycloalkyl" refers to a monovalent substituent derived from a monocyclic or polycyclic non-aromatic hydrocarbon of 3 to 40 carbon atoms. Examples of cycloalkyl include cyclopropyl, cyclopentyl, cyclohexyl, norbornyl, adamantyl, and the like, but are not limited thereto.

[0062] As used herein, the term "heterocycloalkyl" refers to a monovalent substituent derived from a non-aromatic hydrocarbon of 3 to 40 nuclear atoms, in which one or more carbon atoms, preferably 1 to 3 carbon atoms, in the ring are replaced by heteroatoms such as N, O, S, or Se. Examples of heterocycloalkyl include morpholinyl and piperazinyl, but are not limited thereto.

[0063] As used herein, the term "aryl" refers to a monovalent substituent derived from an aromatic hydrocarbon of 6 to 60 carbon atoms, either as a single ring or as a combination of two or more rings. The combination may include pendant rings or fused rings. Examples of aryl include phenyl, naphthyl, phenanthryl, and anthryl, but are not limited thereto.

[0064] As used herein, the term "heteroaryl" refers to a monovalent substituent derived from a monocyclic or polycyclic aromatic hydrocarbon of 5 to 60 ring atoms, where one or more carbon atoms, preferably 1 to 3 carbon atoms, in the ring are replaced by heteroatoms such as N, O, S, or Se. It may include simple pendant or fused rings and may also include fused forms with aryl groups. Examples of such heteroaryl include pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, triazinyl (six-membered monocyclic rings), phenoxathienyl, indolizinyl, indolyl, purinyl, quinolyl, benzothiazolyl, carbazolyl (polycyclic rings), 2-furanyl, N-imidazolyl, 2-isoxazolyl, 2-pyridyl, and 2-pyrimidinyl, but are not limited thereto.

[0065] As used herein, the term "alkoxy" refers to a monovalent substituent represented by R'O-, where R' refers to an alkyl group of 1 to 40 carbon atoms, which may have a linear, branched, or cyclic structure. Examples of alkoxy include methoxy, ethoxy, n-propoxy, 1-propoxy, t-butoxy, n-butoxy, and pentoxy, but are not limited thereto.

[0066] As used herein, the term "aryloxy" refers to a monovalent substituent represented by RO-, where R refers to an aryl group of 5 to 40 carbon atoms. Examples of such aryloxy include phenoxy, naphthoxy, diphenoxy, and the like, but are not limited thereto.

[0067] As used herein, the term "alkylsilyl" refers to a silyl substituted with an alkyl group of 1 to 40 carbon atoms, and includes mono-, di-, and trialkylsilyl groups. In addition, "arylsilyl" refers to a silyl substituted with an aryl group of 5 to 60 carbon atoms, and includes mono-, di-, and triarylsilyl, as well as polyarylsilyl.

[0068] As used herein, the term "alkylboron" refers to a boron group substituted with an alkyl group of 1 to 40 carbon atoms, and "arylboron" refers to a boron substituted with an aryl group of 6 to 60 carbon atoms.

[0069] As used herein, the term "alkylphosphinyl" refers to a phosphine substituted with an alkyl group of 1 to 40 carbon atoms, and includes mono- as well as dialkylphosphinyl. Likewise, "arylphosphinyl" refers to a phosphine substituted with a monoaryl or diaryl group of 6 to 60 carbon atoms, and includes mono- as well as diarylphosphinyl groups.

[0070] As used herein, the term "aryl amine" refers to an amine substituted with an aryl group of 6 to 60 carbon atoms, and includes mono- as well as diaryl amines.

[0071] As used herein, the term "heteroaryl amine" refers to an amine substituted with a heteroaryl group having 5 to 60 nuclear atoms, and includes mono- as well as di-heteroaryl amines.

[0072] As used herein, "(aryl) (heteroaryl)amine" refers to an amine substituted with an aryl group of 6 to 60 carbon atoms and a heteroaryl group having 5 to 60 ring atoms.

[0073] As used herein, the term "fused ring" refers to a fused aliphatic ring of 3 to 40 carbon atoms, a fused aromatic ring of 6 to 60 carbon atoms, a fused heteroaliphatic ring of 3 to 60 ring atoms, a fused heteroaromatic ring of 5 to 60 ring atoms, a spiro ring of 3 to 60 carbon atoms, or a combination thereof.

[0074] No particular limitations are imparted to the mixing ratio of the first organic compound powder and the second organic compound powder. For example, the first and the second organic compound powder may be used at a weight ratio of 1:99 to 99:1. In an embodiment, the pellet may contain the first organic compound powder and the second organic compound powder at a weight ratio of 20:80 to 80:20. This ensures that a uniform mixing ratio is maintained during deposition, allowing stable control of the homogeneous mixing ratio characteristics

[0075] The particle size and shape of the first organic compound powder and the second organic compound powder are not particularly limited, as long as they are known in the art, and for example, the powders may be white or pale yellow.

[0076] In the pellet of the present invention, the first and second organic compound powders may be uniformly mixed together as a compressed state or may be arranged in predetermined regions with a specific pattern as a compressed state. In this way, when the pellet is divided into a first region containing the first organic compound and a second region containing the second organic compound in a predetermined pattern, the mixing ratio of the first and second organic compounds can be kept constant at the set ratio during continuous processes (e.g., roll-to-roll processes) for thin film deposition, compared to when the first organic compound and the second organic compound are mixed together, thereby improving the reproducibility of the thin film formation. Particularly, when the pellet of the present invention is structured such that one organic compound with higher sublimability is encapsulated by another organic compound (see FIGS. 1(a) and (g)), the thin film can be formed with a stable set mixing ratio during deposition, compared to other structures.

[0077] Specifically, as shown in FIG. 1, the pellet (10) of the present invention may include a first region (11) where the first organic compound powder is compressed and a second region (12) disposed to integrate with the first region (11), where the second organic compound powder is compressed. Here, the first and second regions (11, 12) may be arranged in various patterns.

[0078] In an embodiment, as shown in FIGS. 1(a) and (g), the first region (11) and the second region (12) of the pellet (10) may be alternately arranged radially from the center outward.

[0079] In another embodiment, as shown in FIGS. 1(c), (d), (h), (i), (j), and (f), the first region (11) and the second region (12) of the pellet (10) may be arranged in the longitudinal direction (e.g., vertically). Here, the first and second regions (11, 12) may be alternately arranged [see FIGS. 1(d) and (i)].

[0080] In another embodiment, as shown in FIGS. 1(e), (j), and (k), the first region (11) and the second region (12) of the pellet (10) may be alternately arranged in the circumferential direction. In this regard, the first region (11) and the second region (12) may be alternately arranged vertically.

[0081] In yet another example, as shown in FIG. 1(l), the pellet (10) may include, in addition to the first region (11) and the second region (12), a third region (13) where a third organic compound powder, different from the first and second organic compounds, is compressed,.., nth region (not shown) where nth organic compound powders ($4 \leq n$, specifically $4 \leq n \leq 6$) are compressed.

[0082] The shape of the pellet is not particularly limited and may be, for example, polyhedral, cylindrical, or spherical.

[0083] As described above, the pellet of the present invention, which has a specific shape, may have a BET specific surface area smaller than that of a simple mixture of the first and second organic compound powders.

[0084] Additionally, the surface resistance of the pellet of the present invention may be smaller than that of a simple mixture of the first and second organic compound powders.

[0085] Moreover, unlike the simple mixture of the first and second organic compounds, the pellet of the present invention maintains a consistent mixing ratio of the first and second organic compounds before and after deposition, even when forming thin films through continuous processes. Therefore, the pellet of the present invention allows the formation of thin films with a uniform mixing ratio during deposition in continuous processes. In an embodiment, the temporal variation rate before and after deposition of the pellet of the present invention during continuous thin-film deposition may be about 1% or less, specifically about 0.01% to 0.8%.

[0086] The pellet of the present invention can be manufactured by conventional pellet molding methods known in the industry. However, since the pellet of the present invention is not heat-treated during compression, it undergoes no chemical changes and thus maintains the same chemical and physical properties as the first and second organic compound powders and their simple mixtures.

[0087] According to an embodiment, the pellet of the present invention may be manufactured by injecting two or more types of organic compound powders, including the first and second organic compound powders, into a mold and applying a pressure of about 20,000 to 40,000 kgf/cm^2 to same without heat treatment, followed by injection molding.

<Organic Electroluminescent Device>

[0088] The present invention also provides an organic electroluminescent device (hereinafter referred to as "organic EL device") using the aforementioned pellet.

[0089] Specifically, as shown in FIGS. 2 to 4, the organic EL device according to the present invention includes an anode (100), a cathode (200), and at least one organic layer (300) interposed between the anode and the cathode, where at least one of the organic layers is formed from the pellet and is a homogeneous thin film containing the first organic compound and the second organic compound.

[0090] The at least one organic layer (300) may include one or more of a hole injection layer (310), a hole transport layer (320), an emission layer (330), an electron transport auxiliary layer (360), an electron transport layer (340), and an electron injection layer (350). Among them, at least one organic layer (300) is formed from the pellet, creating a homogeneous thin film containing the first and second organic compounds. In this regard, the first organic compound may be a hole-transporting organic compound, and the second organic compound may be an electron-transporting organic compound.

[0091] In an embodiment, the homogeneous thin film may be the emission layer (330). In this regard, the first organic compound may be a hole-transporting host, and the second organic compound may be an electron-transporting host.

[0092] The first organic compound and the second organic compound may be mixed at a weight ratio of 1:99 to 99:1, specifically 20:80 to 80:20.

[0093] The emission layer may further include hosts and/or dopants commonly known in the art in addition to the first and second organic compounds. Here, the total content of the first and second organic compounds may be 0% to 100% by weight, based on the total weight of the host.

[0094] Moreover, the total weight of the host may be about 70% to 99.9% by weight, based on the total weight of the emission layer, and the dopant content may be about 0.1% to 30% by weight, based on the total weight of the emission layer.

[0095] The structure of the organic EL device of the present invention is not particularly limited, but, for example, an anode (100), at least one organic layer (300), and a cathode (200) may be sequentially stacked on a substrate (see FIGS. 2 to 4). In addition, although not shown, the structure may include an insulating layer or an adhesive layer inserted between the electrodes and the organic layer.

[0096] In an embodiment, as shown in FIG. 2, the organic EL device may have a structure in which an anode (100), a hole injection layer (310), a hole transport layer (320), an emission layer (330), an electron transport layer

[0097] (340), and a cathode (200) are sequentially stacked on a substrate. Alternatively, as shown in FIG. 3, an electron injection layer (350) may be positioned between the electron transport layer (340) and the cathode (200). Furthermore, an electron transport auxiliary layer (360) may be positioned between the emission layer (330) and the electron transport layer (340) (see FIG. 4).

[0098] The organic EL device of the present invention can be manufactured by forming the organic layers and electrodes using materials and methods known in the art, except that at least one organic layer (300) (e.g., the emission layer (330)) is a homogeneous thin film formed from the aforementioned pellet.

[0099] The organic layers may be formed by dry film formation methods such as vacuum deposition, sputtering, plasma deposition, or ion plating.

[0100] The substrate usable in the present invention is not particularly limited, and non-limiting examples include silicon wafers, quartz, glass plates, metal plates, plastic films, and sheets.

[0101] Examples of anode materials include metals such as vanadium, chromium, copper, zinc, and gold, or alloys thereof; metal oxides such as zinc oxide, indium oxide, indium tin oxide (ITO), and indium zinc oxide (IZO); combinations of metals and oxides such as ZnO:Al or SnO_2:Sb; conductive polymers such as polythiophene, poly(3-methylthiophene), poly[3,4-(ethylene-1,2-dioxy)thiophene] (PEDT), polypyrrole, or polyaniline; and carbon black, but are not limited thereto.

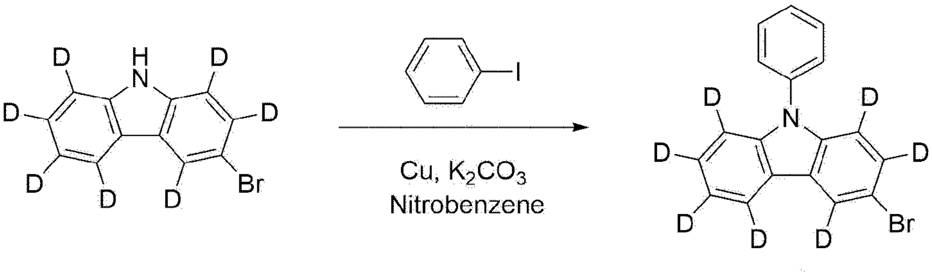
[0102] Examples of cathode materials include metals such as magnesium, calcium, sodium, potassium, titanium, indium, yttrium, lithium, gadolinium, aluminum, silver (Ag), tin, or lead, or alloys thereof; and multilayer structures such as LiF/Al or LiO_2/Al, but are not limited thereto.

[0103] Moreover, the hole injection layer, hole transport layer, emission layer, and electron injection layer are not particularly limited, and conventional materials known in the art may be used.

[0104] A better understanding of the present invention may be obtained via the following examples, which are set forth to illustrate, but are not to be construed to limit, the present invention.

<PREPARATION EXAMPLE 1-1> Synthesis of Cz-D1

[0105]



Cz-D1

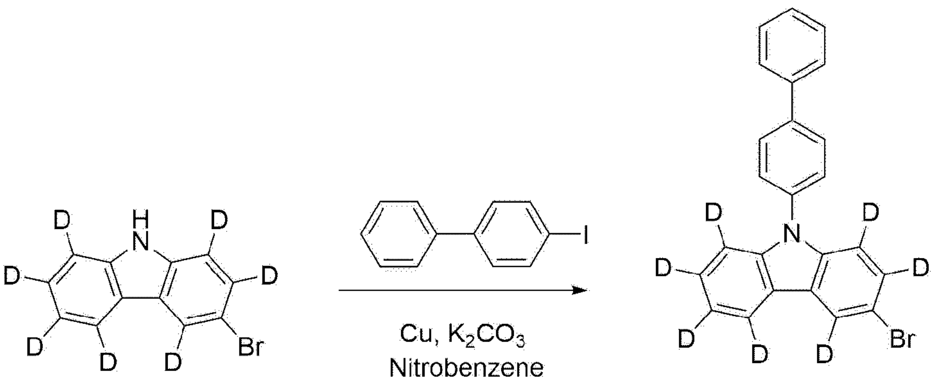
[0106] Under a nitrogen atmosphere, 3-bromo-9H-carbazole-1,2,4,5,6,7,8-d7 (134.3 g, 530.6 mmol), iodobenzene (130.0 g, 636.7 mmol), Cu (16.8 g, 265.3 mmol), K_2CO_3 (146.7 g, 1,061.3 mmol), and toluene (1000 ml) were mixed and stirred at 110°C for 12 hours.

[0107] After completion of the reaction, the reaction mixture was subjected to extraction with ethyl acetate and the extract was dried over $MgSO_4$. Purification by column chromatography (hexane : EA = 5:1 (v/v)) afforded Cz-D1 (125.7 g, yield 72%).

[0108] Mass (Calcd.: 329.25, Found: 329 g/mol)

<PREPARATION EXAMPLE 1-2> Synthesis of Cz-D2

[0109]



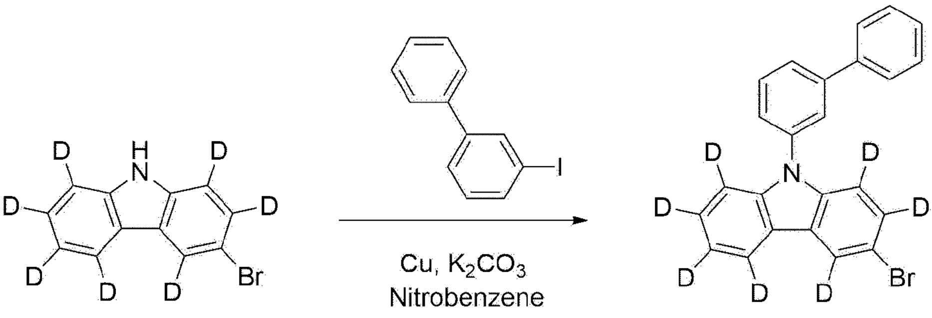
Cz-D2

[0110] The same procedure as in Preparation Example 1-1, with the exception of using 4-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D2 (135.5 g, yield 63%).

[0111] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 1-3> Synthesis of Cz-D3

[0112]



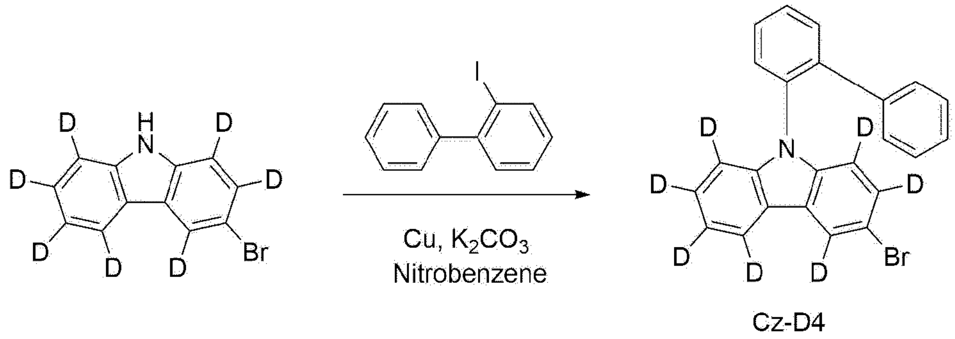
Cz-D3

[0113] The same procedure as in Preparation Example 1-1, with the exception of using 3-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D3 (148.4 g, yield 69%).

[0114] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 1-4> Synthesis of Cz-D4

[0115]

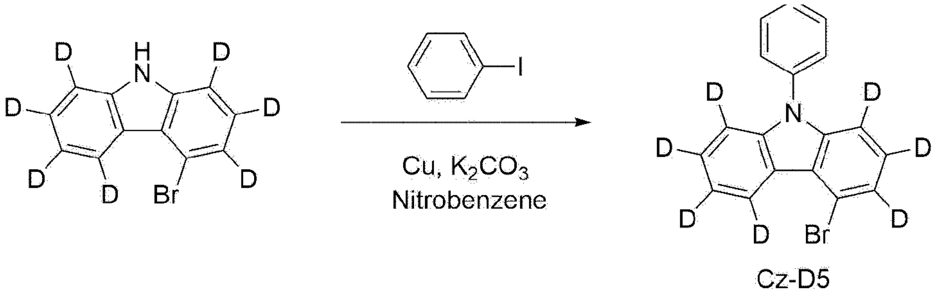


[0116] The same procedure as in Preparation Example 1-1, with the exception of using 2-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D4 (96.8 g, yield 45%).

[0117] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 2-1> Synthesis of Cz-D5

[0118]

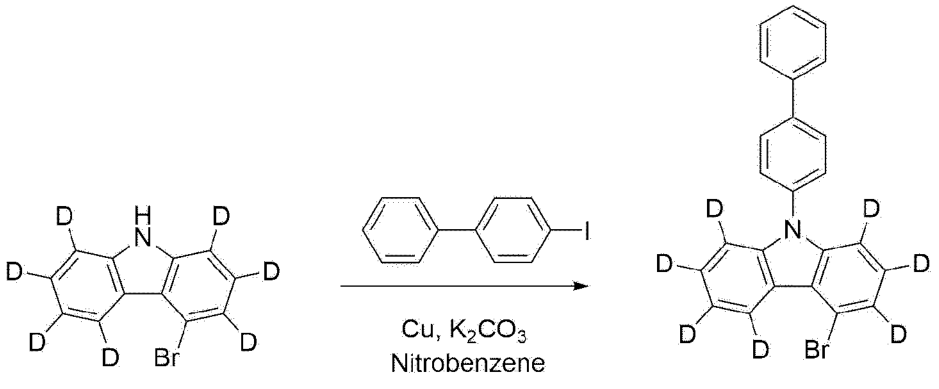


[0119] The same procedure as in Preparation Example 1-1, with the exception of using 4-bromo-9H-carbazole-1,2,3,5,6,7,8-d7 (134.3 g, 530.6 mmol) instead of 3-bromo-9H-carbazole-1,2,4,5,6,7,8-d7, was conducted to afford the target compound Cz-D5 (117.1 g, yield 67%).

[0120] Mass (Calcd.: 329.25, Found: 329 g/mol)

<PREPARATION EXAMPLE 2-2> Synthesis of Cz-D6

[0121]



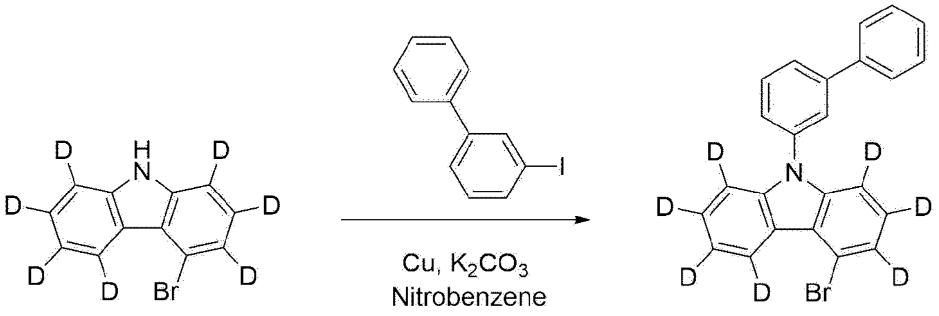
Cz-D6

[0122] The same procedure as in Preparation Example 2-1, with the exception of using 4-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D6 (139.8 g, yield 65%).

[0123] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 2-3> Synthesis of Cz-D7

[0124]



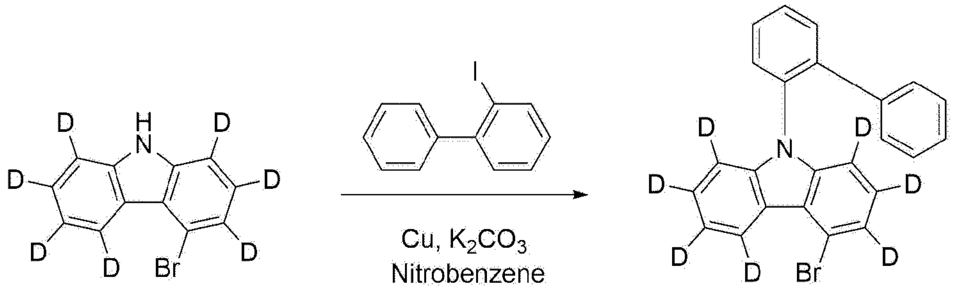
Cz-D7

[0125] The same procedure as in Preparation Example 2-1, with the exception of using 3-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D7 (152.7 g, yield 71%).

[0126] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 2-4> Synthesis of Cz-D8

[0127]



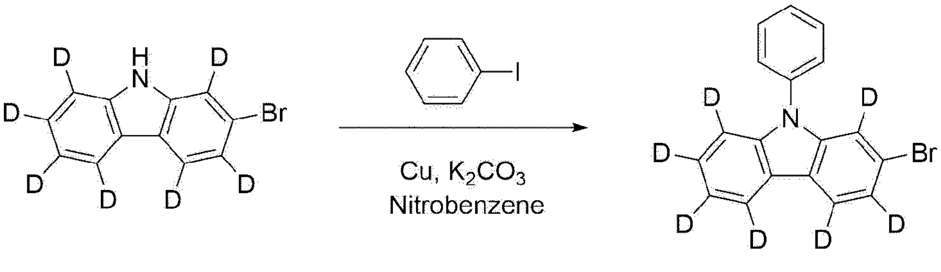
Cz-D8

[0128] The same procedure as in Preparation Example 2-1, with the exception of using 2-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D8 (75.2 g, yield 35%).

[0129] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 3-1> Synthesis of Cz-D9

[0130]



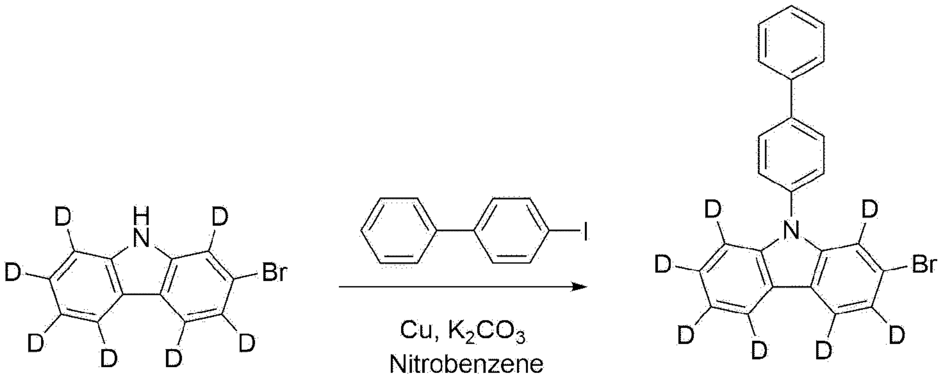
Cz-D9

[0131] The same procedure as in Preparation Example 1-1, with the exception of using 2-bromo-9H-carbazole-1,3,4,5,6,7,8-d7 (134.3 g, 530.6 mmol) instead of 3-bromo-9H-carbazole-1,2,4,5,6,7,8-d7, was conducted to afford the target compound Cz-D9 (134.5 g, yield 77%).

[0132] Mass (Calcd.: 329.25, Found: 329 g/mol)

<PREPARATION EXAMPLE 3-2> Synthesis of Cz-D10

[0133]



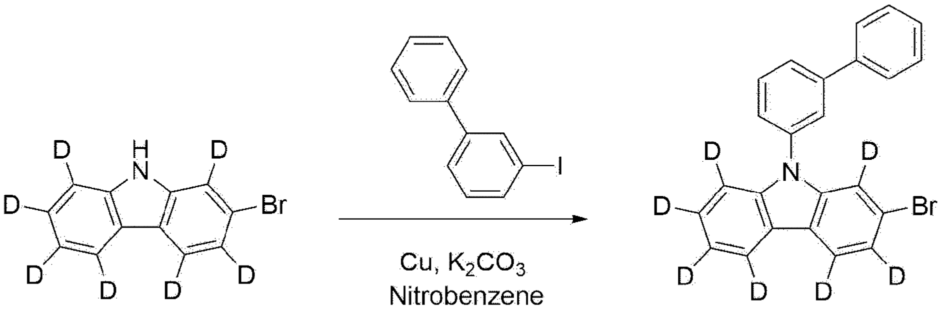
Cz-D10

[0134] The same procedure as in Preparation Example 3-1, with the exception of using 4-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D10 (159.1 g, yield 74%).

[0135] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 3-3> Synthesis of Cz-D11

[0136]



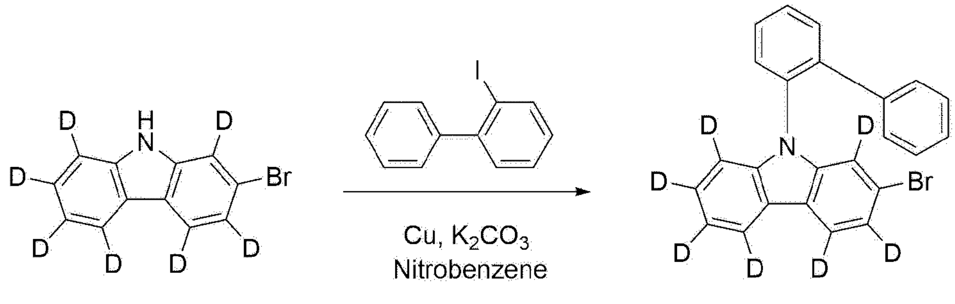
Cz-D11

[0137] The same procedure as in Preparation Example 3-1, with the exception of using 3-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D11 (163.4 g, yield 76%).

[0138] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 3-4> Synthesis of Cz-D12

[0139]



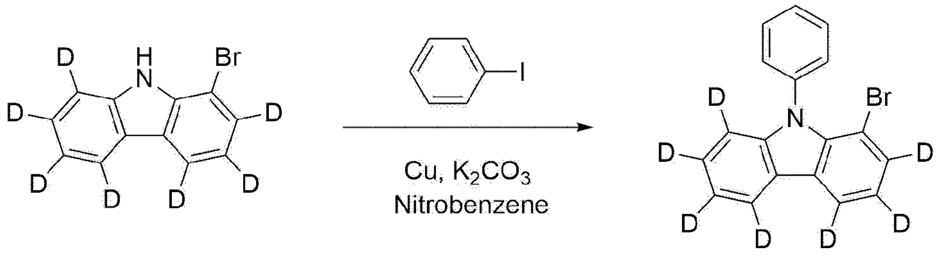
Cz-D12

[0140] The same procedure as in Preparation Example 3-1, with the exception of using 2-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of Iodobenzene, was conducted to afford the target compound Cz-D12 (92.4 g, yield 43%).

[0141] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 4-1> Synthesis of Cz-D13

[0142]



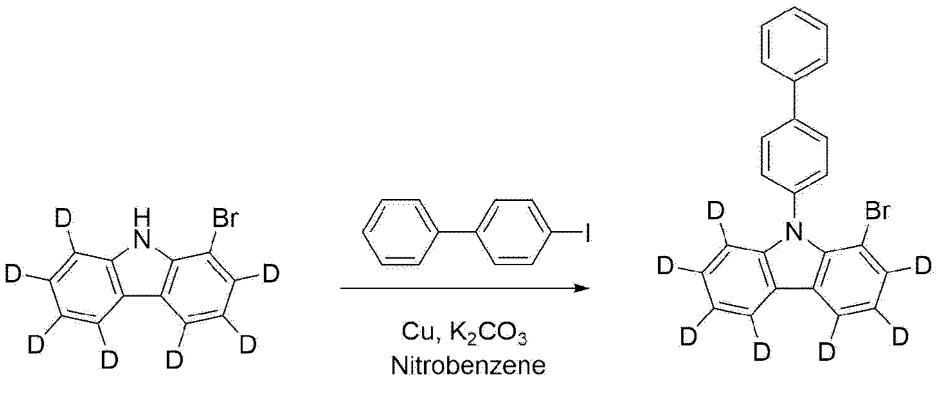
Cz-D13

[0143] The same procedure as in Preparation Example 1-1, with the exception of using 1-bromo-9H-carbazole-2,3,4,5,6,7,8-d7 (134.3 g, 530.6 mmol) instead of 3-bromo-9H-carbazole-1,2,4,5,6,7,8-d7, was conducted to afford the target compound Cz-D13 (94.3 g, yield 54%).

[0144] Mass (Calcd.: 329.25, Found: 329 g/mol)

<PREPARATION EXAMPLE 4-2> Synthesis of Cz-D14

[0145]



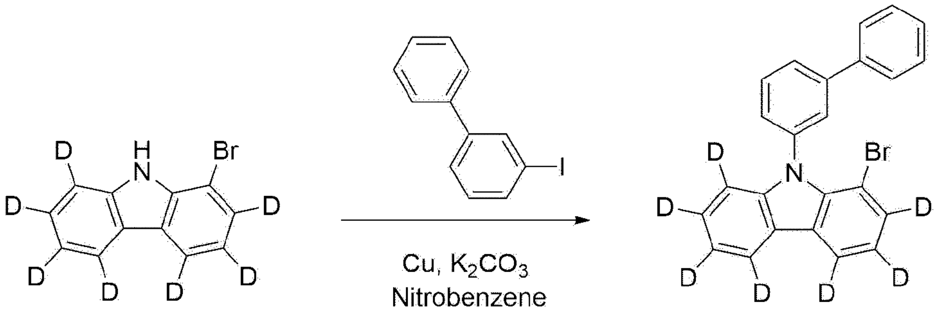
Cz-D14

[0146] The same procedure as in Preparation Example 4-1, with the exception of using 4-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D14 (122.6 g, yield 57%).

[0147] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 4-3> Synthesis of Cz-D15

[0148]



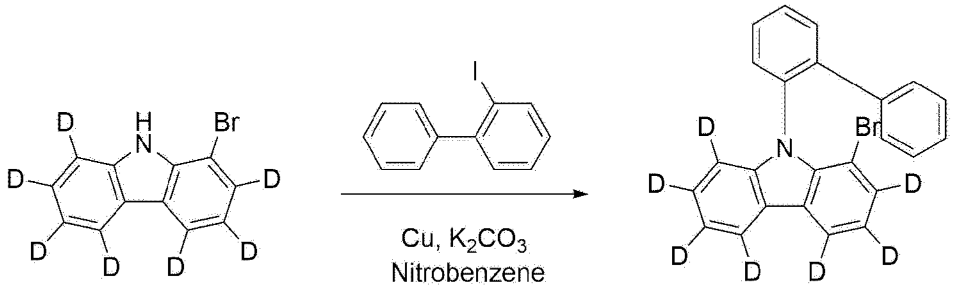
Cz-D15

[0149] The same procedure as in Preparation Example 4-1, with the exception of using 3-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D15 (111.8 g, yield 52%).

[0150] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 4-4> Synthesis of Cz-D16

[0151]



Cz-D16

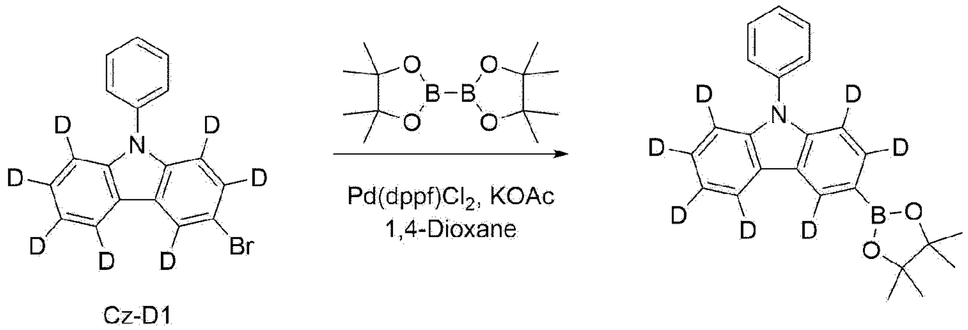
[0152] The same procedure as in Preparation Example 4-1, with the exception of using 2-iodo-1,1'-biphenyl (178.3 g, 636.7 mmol) instead of iodobenzene, was conducted to afford the target compound Cz-D16 (68.8 g, yield 32%).

[0153] Mass (Calcd.: 405.35, Found: 405 g/mol)

<PREPARATION EXAMPLE 5-1> Synthesis of BCz-D1

<Step 1> Synthesis of 9-phenyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-9H-carbazole-1,2,4,5,6,7,8-d7

[0154]



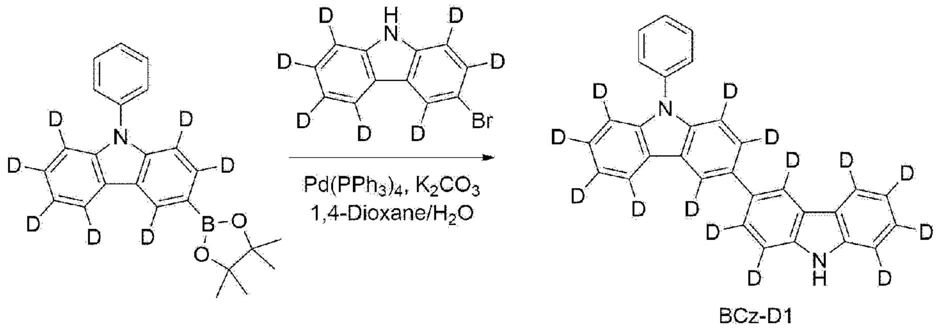
[0155] Under a nitrogen atmosphere, Cz-D1 (100.0 g, 303.7 mmol), 4,4,4',4',5,5, 5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (84.8 g, 334.1 mmol), Pd(dppf)Cl_2 (26.6 g, 30.3 mmol), KOAc (85.8 g, 911.1 mmol), and 1,4-Dioxane (1000 ml) were mixed and stirred at 130°C for 12 hours.

[0156] After completion of the reaction, the reaction mixture was subjected to extraction with ethyl acetate and the extract was dried over $MgSO_4$. Purification by column chromatography (Hexane:EA = 8:1 (v/v)) afforded 9-phenyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-9H-carbazole-1,2,4,5,6,7,8-d7 (96.0 g, yield 84%).

[0157] Mass (Calcd.: 376.3, Found: 376 g/mol)

<Step 2> Synthesis of BCz-D1

[0158]



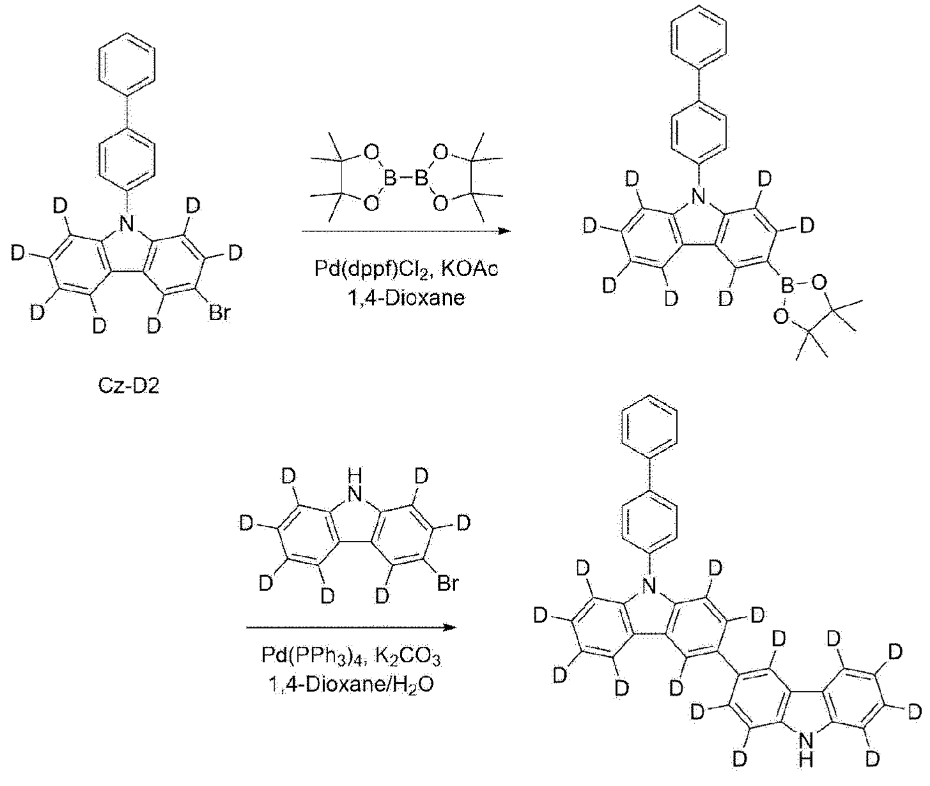
[0159] Under a nitrogen atmosphere, 9-phenyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-9H-carbazole-1,2,4,5,6,7,8-d7 (96.0 g, 255.1 mmol), 3-bromo-9H-carbazole-1,2,4,5,6,7,8-d7 (77.5 g, 306.1 mmol), $Pd(PPh_3)_4$ (14.7 g, 12.7 mmol), K_2CO_3 (88.1 g, 637.8 mmol), 1,4-dioxane/H_2O (1000 ml/250 ml) were mixed and stirred at 120°C for 4 hours.

[0160] After completion of the reaction, the reaction mixture was subjected to extraction with methylene chloride and the extract was added with $MgSO_4$ and filtered. The solvent was removed from the organic layer thus obtained, followed by purification by column chromatography (Hexane:EA = 7:1 (v/v)) to afford BCz-D1 (71.1 g, yield 66%).

[0161] Mass (Calcd.: 422.59, Found: 422 g/mol)

<PREPARATION EXAMPLE 5-2> Synthesis of BCz-D2

[0162]



Cz-D2

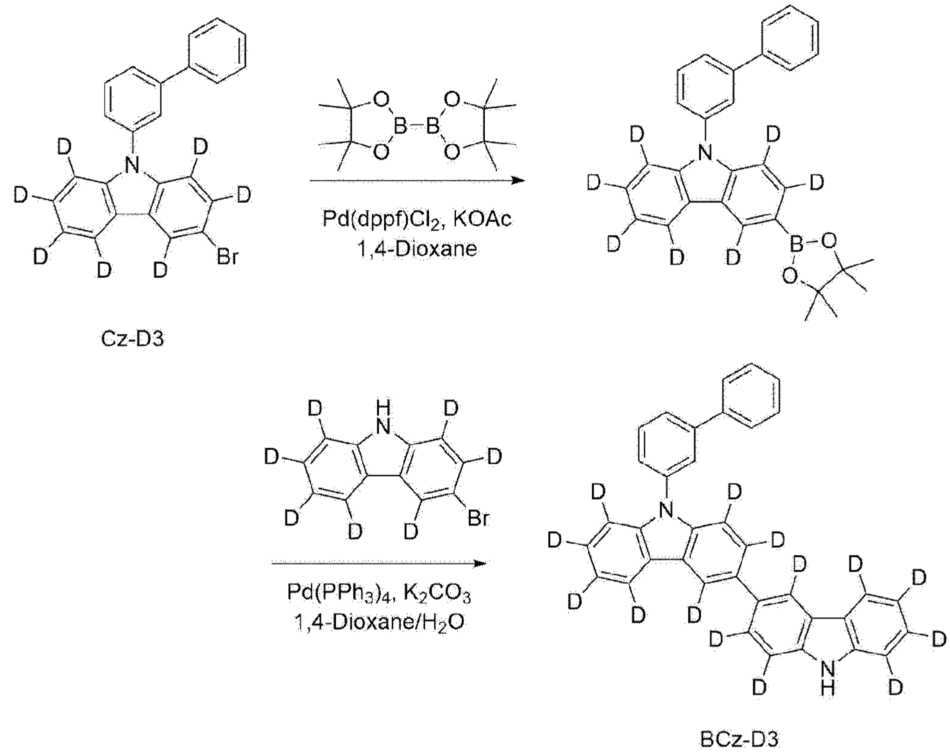
BCz-D2

[0163] The same procedure as in Preparation Example 5-1, with the exception of using Cz-D2(100g, 246.7 mmol) instead of Cz-D1, was conducted to afford the target compound BCz-D2 (66.4 g, final yield 54.0%).

[0164] Mass (Calcd.: 498.69, Found: 498 g/mol)

<PREPARATION EXAMPLE 5-3> Synthesis of BCz-D3

[0165]

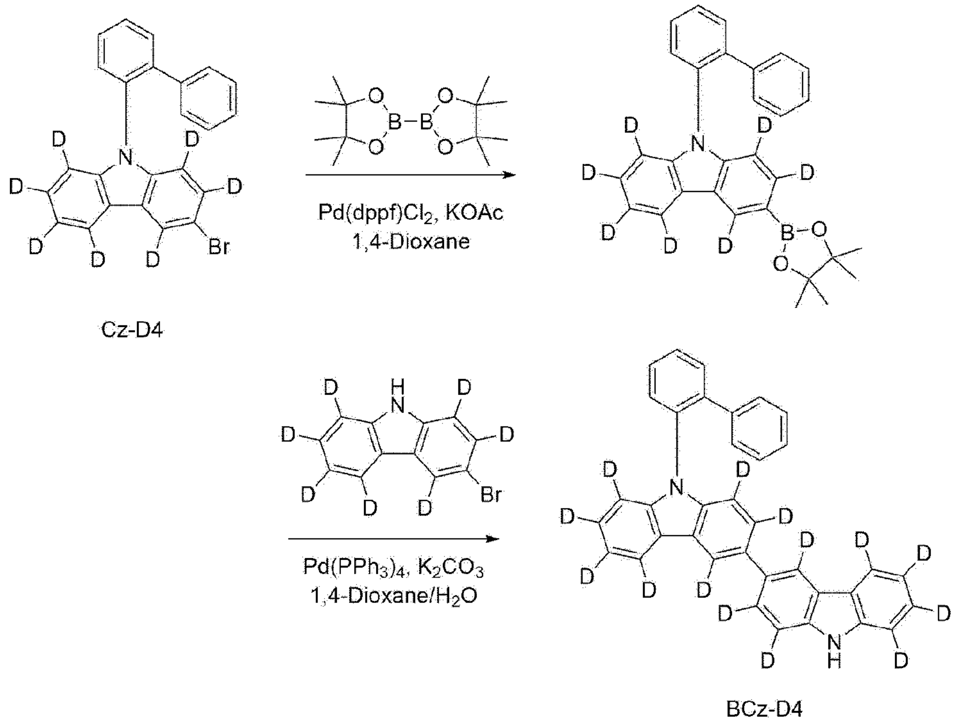


[0166] The same procedure as in Preparation Example 5-1, with the exception of using Cz-D3(100g, 246.7 mmol) instead of Cz-D1, was conducted to afford the target compound BCz-D3 (59.7 g, final yield 48.5%).

[0167] Mass (Calcd.: 498.69, Found: 498 g/mol)

<PREPARATION EXAMPLE 5-4> Synthesis of BCz-D4

[0168]

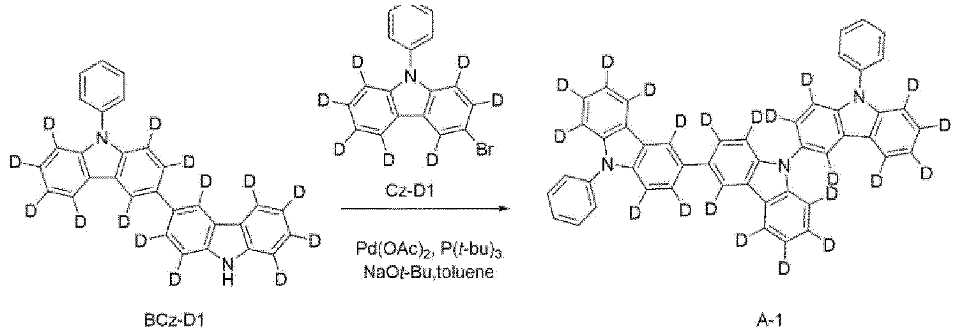


[0169] The same procedure as in Preparation Example 5-1, with the exception of using Cz-D4 (100g, 246.7 mmol) obtained in Preparation Example 1-4 instead of Cz-D1, was conducted to afford the target compound BCz-D4 (59.4 g, final yield 48.3%).

[0170] Mass (Calcd.: 498.69, Found: 498 g/mol)

[SYNTHESIS EXAMPLE 1] Synthesis of A-1

[0171]

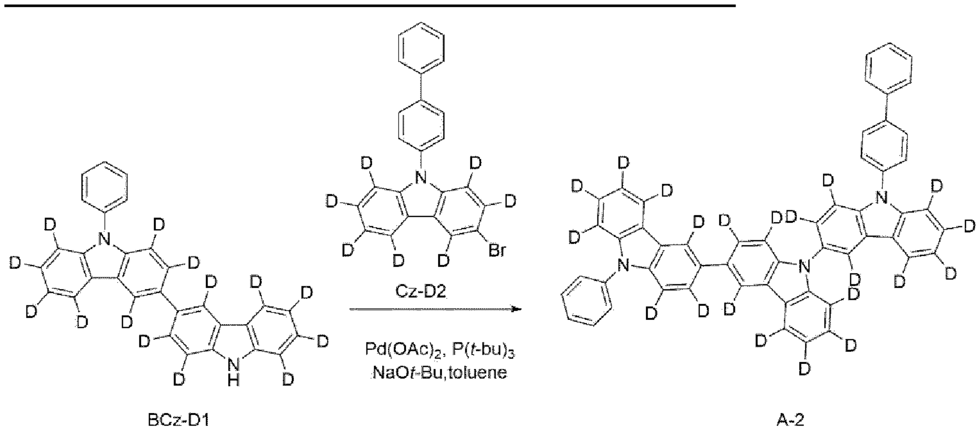


[0172] Under a nitrogen atmosphere, BCz-D1 (10.0 g, 23.6 mmol) obtained Preparation Example 5-1, Cz-D1 (9.3 g, 28.3 mmol) obtained Preparation Example 1-1, $Pd(OAc)_2$ (1.36 g, 1.18 mmol), $P(t\text{-}Bu)_3$ (0.57 ml, 2.36 mmol), NaO(*t*-Bu) (4.55 g, 47.3 mmol), and toluene (100 ml) were mixed and stirred at 110°C for 5 hours. After completion of the reaction, the toluene was concentrated and the solid salt was filtered, followed by filtration through recrystallization to afford the target compound A-1 (13.0 g, yield 82%).

[0173] Mass (Calcd.: 670.93, Found: 670 g/mol)

[SYNTHESIS EXAMPLE 2] Synthesis of A-2

[0174]

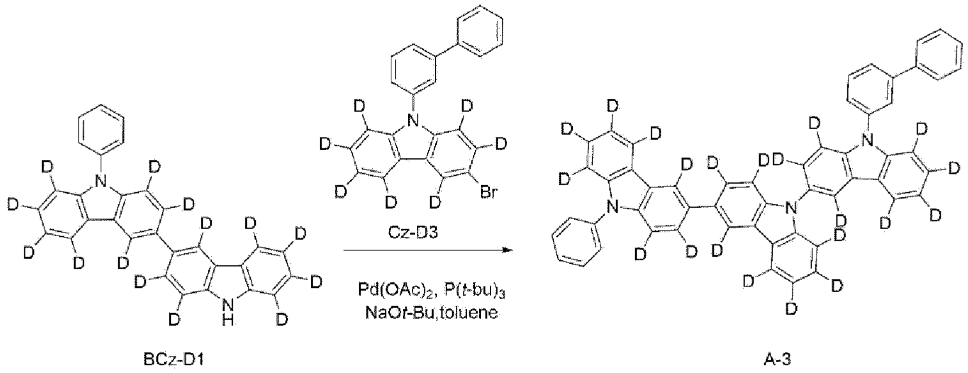


[0175] The same procedure as in Synthesis Example 1, with the exception of using Cz-D2 (10.0 g, 23.6 mmol) prepared in Preparation Example 1-2 instead of Cz-D1, was conducted to afford the target compound A-2 (13.8 g, yield 78%).

[0176] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 3] Synthesis of A-3

[0177]

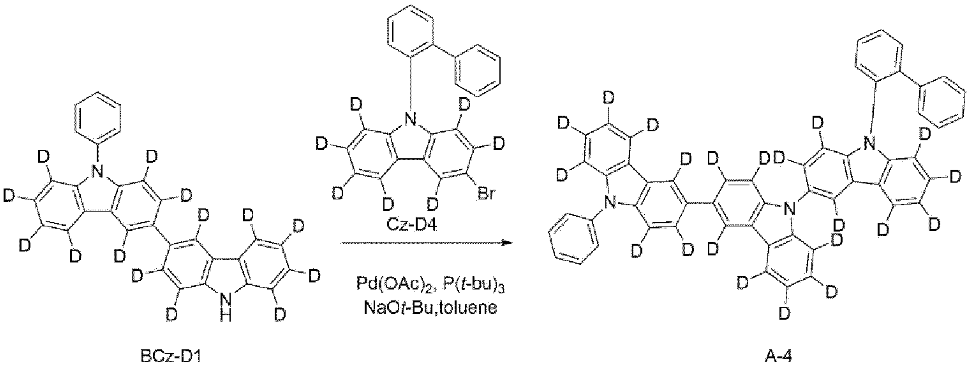


[0178] The same procedure as in Synthesis Example 1, with the exception of using Cz-D3 (10.0 g, 23.6 mmol) obtained in Preparation Example 1-3 instead of Cz-D1, was conducted to afford the target compound A-3 (13.2 g, yield 75%).

[0179] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 4] Synthesis of A-4

[0180]

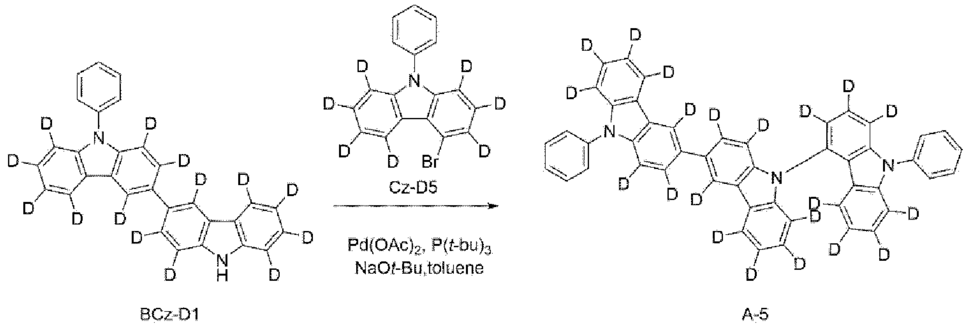


[0181] The same procedure as in Synthesis Example 1, with the exception of using Cz-D4 (10.0 g, 23.6 mmol) obtained in Preparation Example 1-4 instead of Cz-D1, was conducted to afford the target compound A-4 (12.2 g, yield 69%).

[0182] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 5] Synthesis of A-5

[0183]

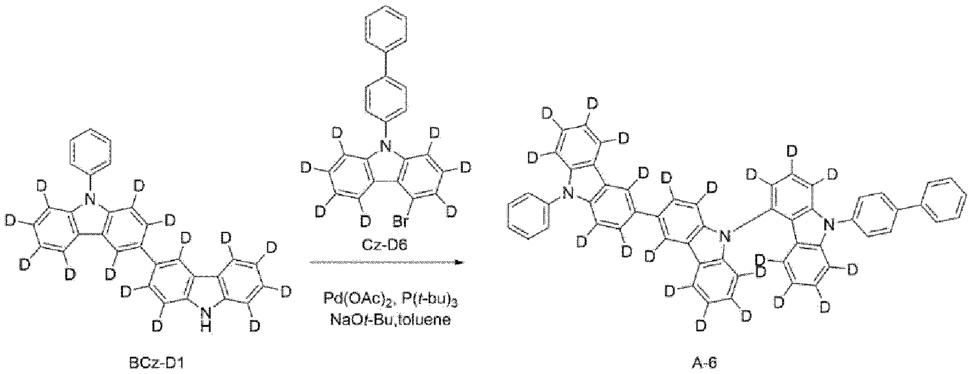


[0184] The same procedure as in Synthesis Example 1, with the exception of using Cz-D5 obtained in Preparation Example 2-1 instead of Cz-D1, was conducted to afford the target compound A-5 (8.73 g, yield 55%).

[0185] Mass (Calcd.: 670.93, Found: 670 g/mol)

[SYNTHESIS EXAMPLE 6] Synthesis of A-6

[0186]

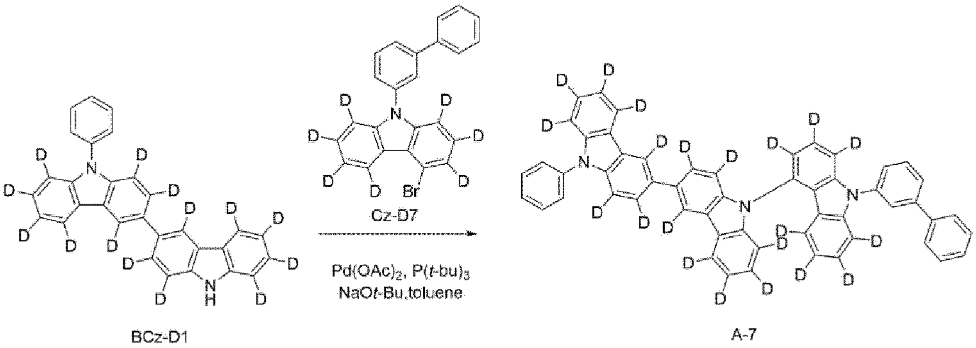


[0187] The same procedure as in Synthesis Example 1, with the exception of using Cz-D6 (10.0 g, 23.6 mmol) obtained in Preparation Example 2-2 instead of Cz-D1, was conducted to afford the target compound A-6 (7.42 g, yield 42%).

[0188] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 7] Synthesis of A-7

[0189]

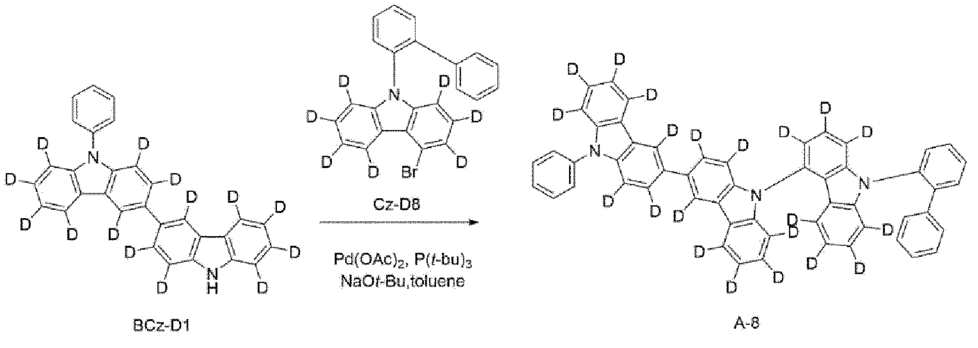


[0190] The same procedure as in Synthesis Example 1, with the exception of using Cz-D7 (10.0 g, 23.6 mmol) obtained in Preparation Example 2-3 instead of Cz-D1, was conducted to afford the target compound A-7 (8.83 g, yield 50%).

[0191] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 8] Synthesis of A-8

[0192]

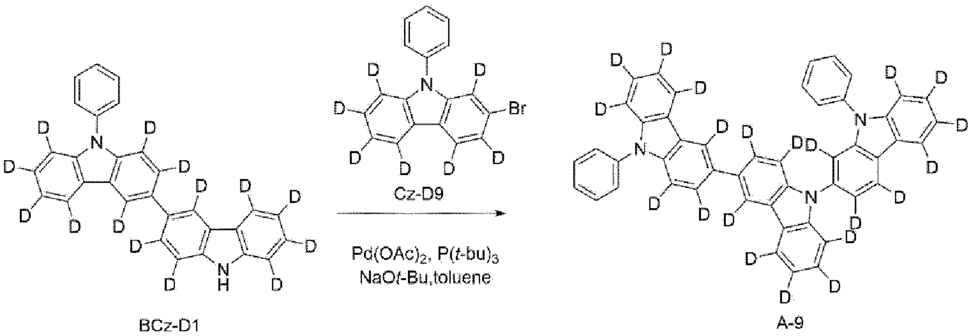


[0193] The same procedure as in Synthesis Example 1, with the exception of using Cz-D8 (10.0 g, 23.6 mmol) obtained in Preparation Example 2-4 instead of Cz-D1, was conducted to afford the target compound A-8 (9.89 g, yield 56%).

[0194] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 9] Synthesis of A-9

[0195]

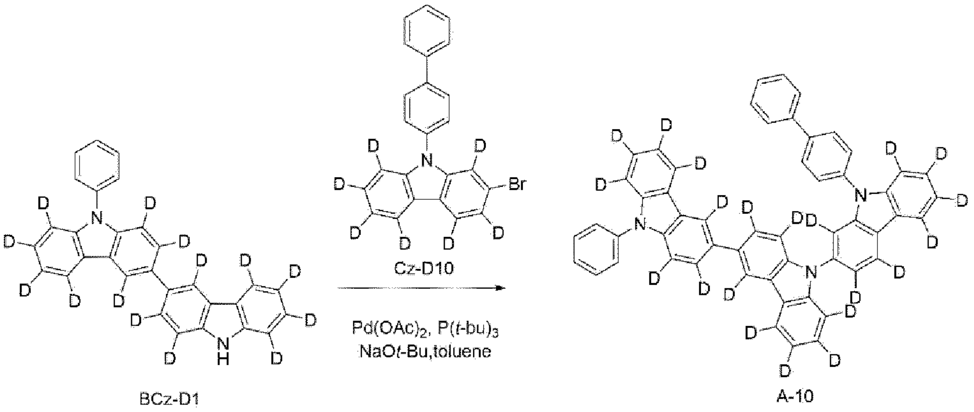


[0196] The same procedure as in Synthesis Example 1, with the exception of using Cz-D9 (9.3 g, 23.6 mmol) obtained in Preparation Example 3-1 instead of Cz-D1, was conducted to afford the target compound A-9 (8.41 g, yield 53%).

[0197] Mass (Calcd.: 670.93, Found: 670 g/mol)

[SYNTHESIS EXAMPLE 10] Synthesis of A-10

[0198]

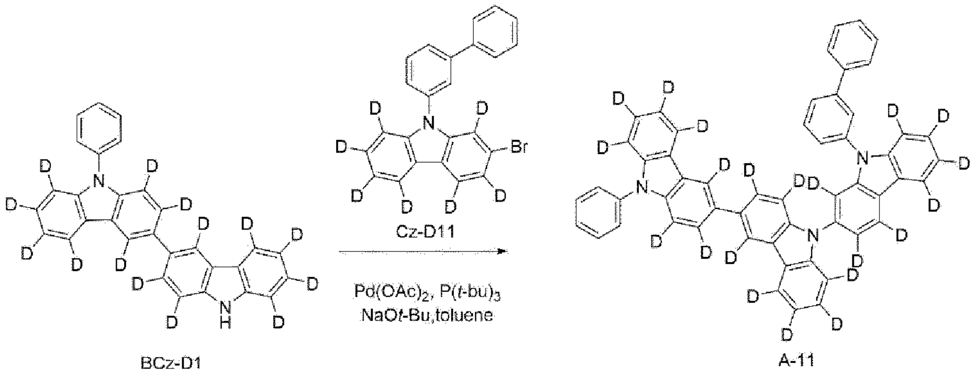


[0199] The same procedure as in Synthesis Example 1, with the exception of using Cz-D10 (10.0 g, 23.6 mmol) obtained in Preparation Example 3-2 instead of Cz-D1, was conducted to afford the target compound A-10 (8.66 g, yield 49%).

[0200] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 11] Synthesis of A-11

[0201]

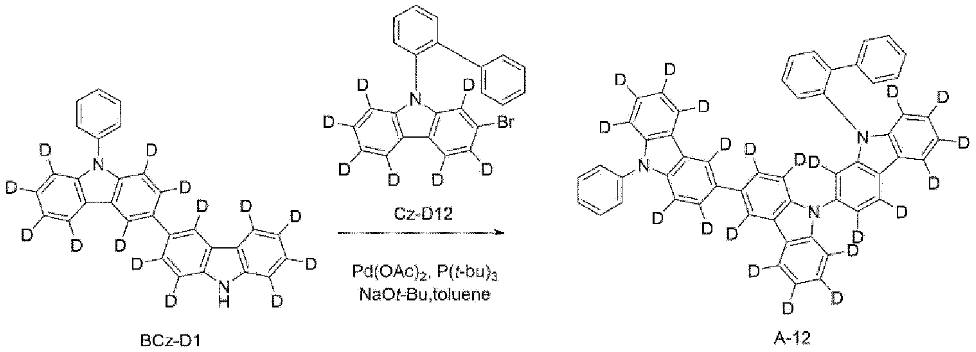


[0202] The same procedure as in Synthesis Example 1, with the exception of using Cz-D11 (10.0 g, 23.6 mmol) obtained in Preparation Example 3-3 instead of Cz-D1, was conducted to afford the target compound A-11 (9.01 g, yield 51%).

[0203] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 12] Synthesis of A-12

[0204]

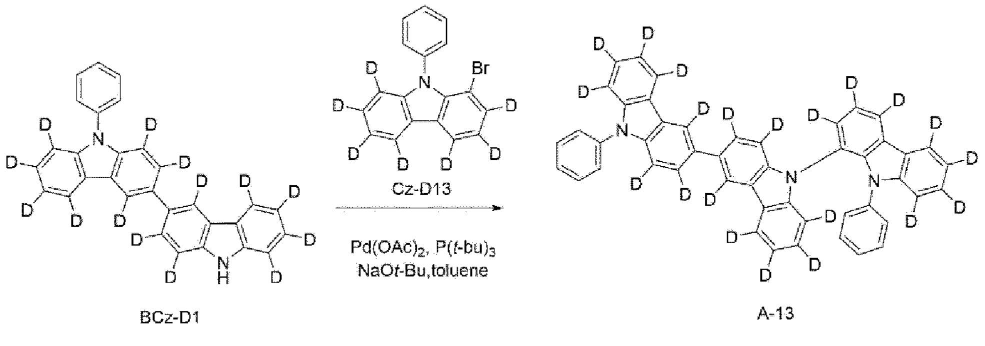


[0205] The same procedure as in Synthesis Example 1, with the exception of using Cz-D12 (10.0 g, 23.6 mmol) obtained in Preparation Example 3-4 instead of Cz-D1, was conducted to afford the target compound A-12 (9.19 g, yield 52%).

[0206] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 13] Synthesis of A-13

[0207]

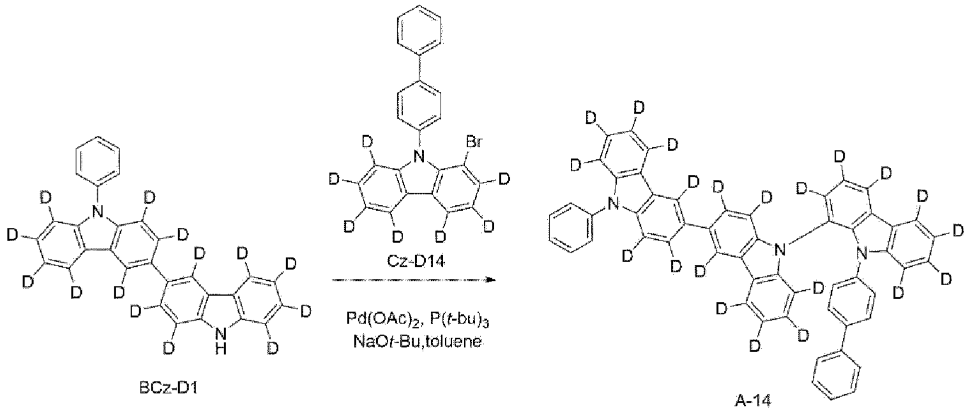


[0208] The same procedure as in Synthesis Example 1, with the exception of using Cz-D13 (9.3 g, 23.6 mmol) obtained in Preparation Example 4-1 instead of Cz-D1, was conducted to afford the target compound A-13 (9.52 g, yield 60%).

[0209] Mass (Calcd.: 670.93, Found: 670 g/mol)

[SYNTHESIS EXAMPLE 14] Synthesis of A-14

[0210]

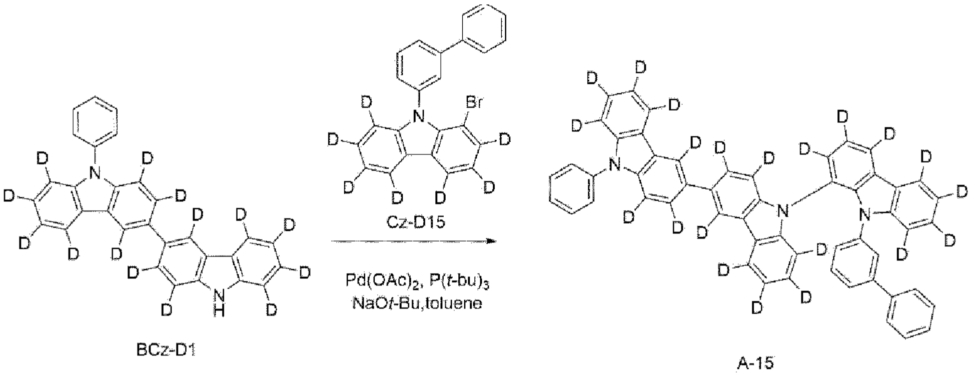


[0211] The same procedure as in Synthesis Example 1, with the exception of using Cz-D14 (10.0 g, 23.6 mmol) obtained in Preparation Example instead of Cz-D1, was conducted to afford the target compound A-14 (10.78 g, yield 61%).

[0212] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 15] Synthesis of A-15

[0213]

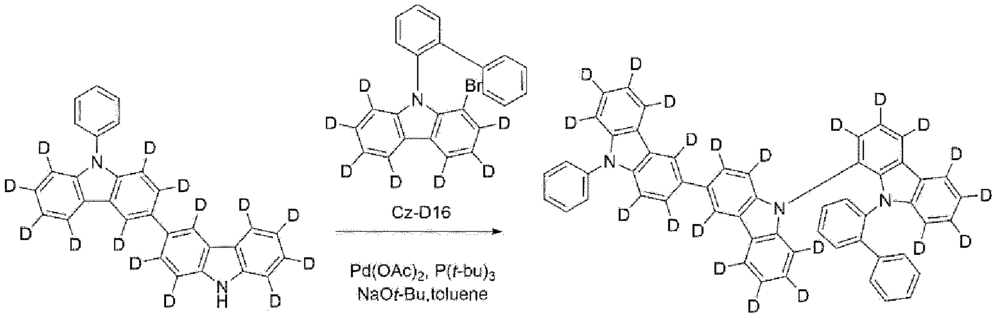


[0214] The same procedure as in Synthesis Example 1, with the exception of using Cz-D15 (10.0 g, 23.6 mmol) obtained in Preparation Example 4-3 instead of Cz-D1, was conducted to afford the target compound A-15 (11.13 g, yield 63%).

[0215] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 16] Synthesis of A-16

[0216]



BCz-D1

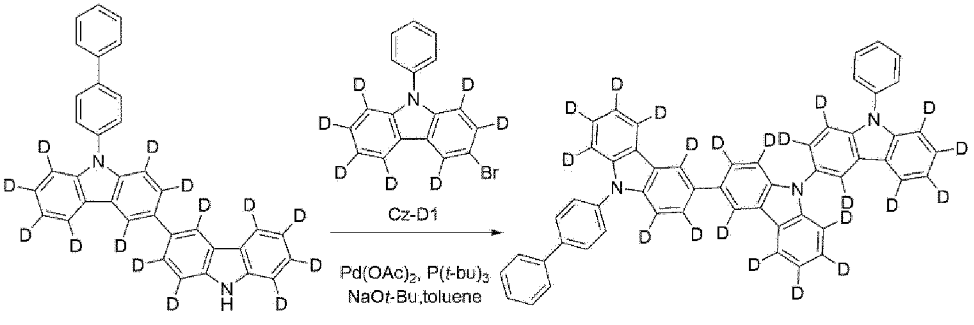
A-16

[0217] The same procedure as in Synthesis Example 1, with the exception of using Cz-D16 (10.0 g, 23.6 mmol) obtained in Preparation Example instead of Cz-D1, was conducted to afford the target compound A-16 (9.02 g, yield 51%).

[0218] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 17] B-1

[0219]



BCz-D2

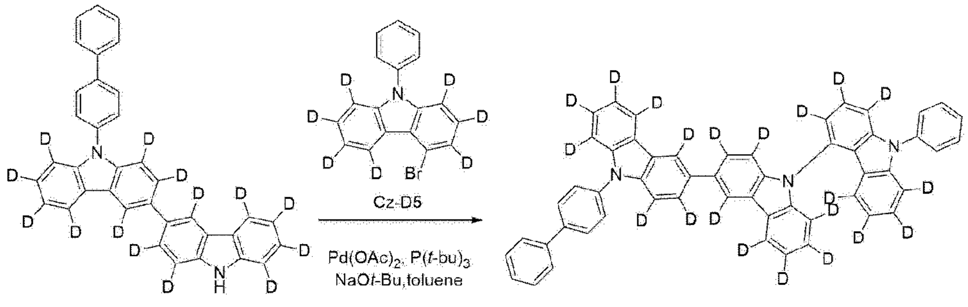
B-1

[0220] Under a nitrogen atmosphere, BCz-D2 (10.0 g, 20.1 mmol) obtained in Preparation Example 5-2, Cz-D1 (7.9 g, 24.1 mmol) obtained in Preparation Example 1-1, $Pd(OAc)_2$ (1.15 g, 1.0 mmol), $P(t\text{-}Bu)_3$ (0.49 ml, 2.0 mmol), NaO(*t*-Bu) (3.85 g, 40.1 mmol), and toluene (100 ml) were mixed and stirred at 110°C for 5 hours. After completion of the reaction, the toluene was concentrated and the solid salt was filtered, followed by filtration through recrystallization to afford the target compound B-1 (10.2 g, yield 62%).

[0221] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 18] B-2

[0222]



BCz-D2

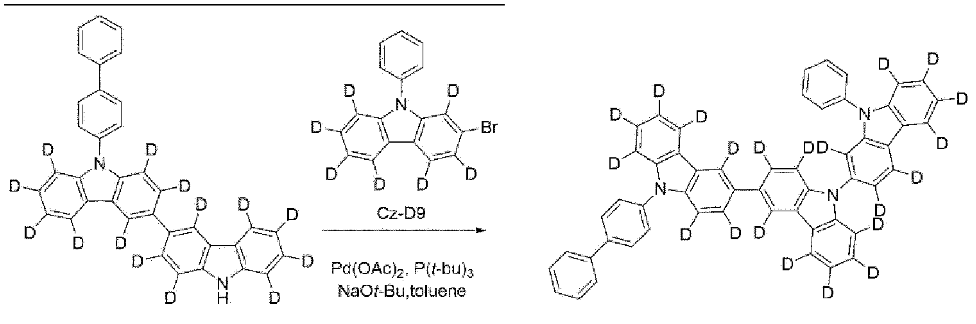
B-2

[0223] The same procedure as in Synthesis Example 17, with the exception of using Cz-D5 (7.9 g, 24.1 mmol) obtained in Preparation Example instead of Cz-D1, was conducted to afford the target compound B-2 (8.5 g, yield 48%).

[0224] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 19] B-3

[0225]



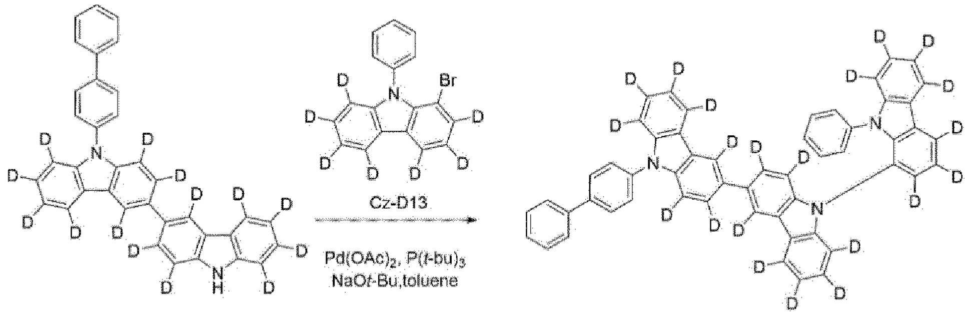
BCz-D2 B-3

[0226] The same procedure as in Synthesis Example 17, with the exception of using Cz-D9 (7.9 g, 24.1 mmol) obtained in Preparation Example 3-1 instead of Cz-D1, was conducted to afford the target compound B-3 (11.1 g, yield 63%).

[0227] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 20] B-4

[0228]



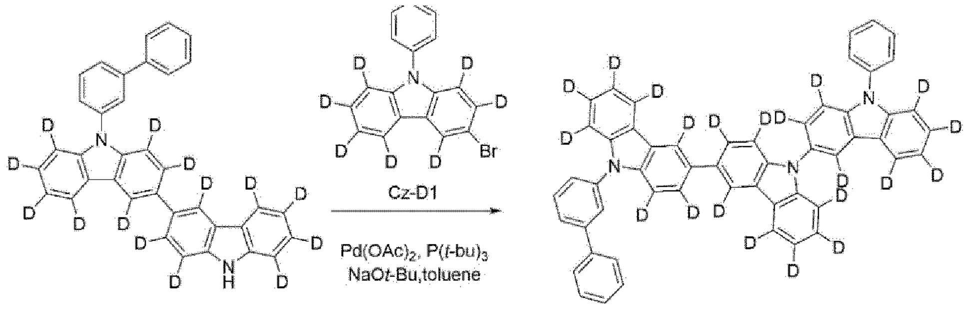
BCz-D2 B-4

[0229] The same procedure as in Synthesis Example 17, with the exception of using Cz-D13 (7.9 g, 24.1 mmol) obtained in Preparation Example instead of Cz-D1, was conducted to afford the target compound B-4 (7.42 g, yield 42%).

[0230] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 21] C-1

[0231]



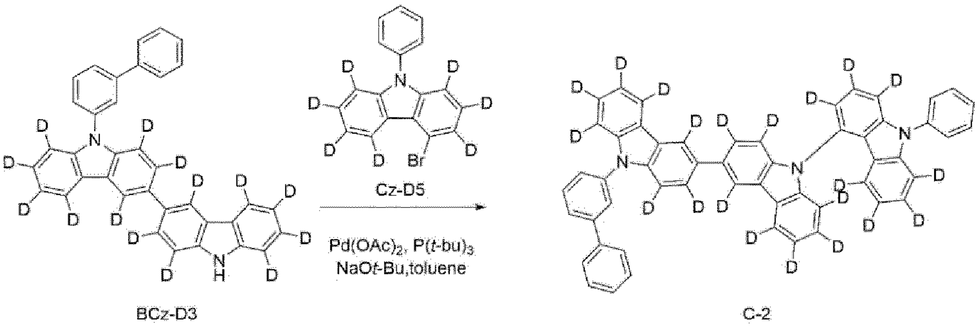
BCz-D3 C-1

[0232] Under a nitrogen atmosphere, BCz-D3 (10.0 g, 20.1 mmol) obtained in Preparation Example 5-3, Cz-D1 (7.9 g, 24.1 mmol) obtained in Preparation Example 1-1, $Pd(OAc)_2$ (1.15 g, 1.0 mmol), P(*t*-Bu)$_3$ (0.49 ml, 2.0 mmol), NaO(*t*-Bu) (3.85 g, 40.1 mmol), and toluene (100 ml) were mixed and stirred at 110°C for 5 hours. After completion of the reaction, the toluene was concentrated and the solid salt was filtered, followed by filtration through recrystallization to afford the target compound C-1 (9.4 g, yield 63%).

[0233] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 22] C-2

[0234]

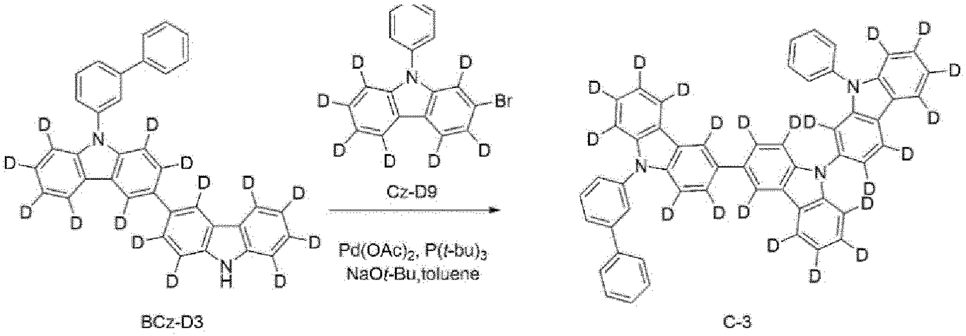


[0235] The same procedure as in Synthesis Example 21, with the exception of using Cz-D5 (7.9 g, 24.1 mmol) obtained in Preparation Example instead of Cz-D1, was conducted to afford the target compound C-2 (7.78 g, yield 44%).

[0236] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 23] C-3

[0237]

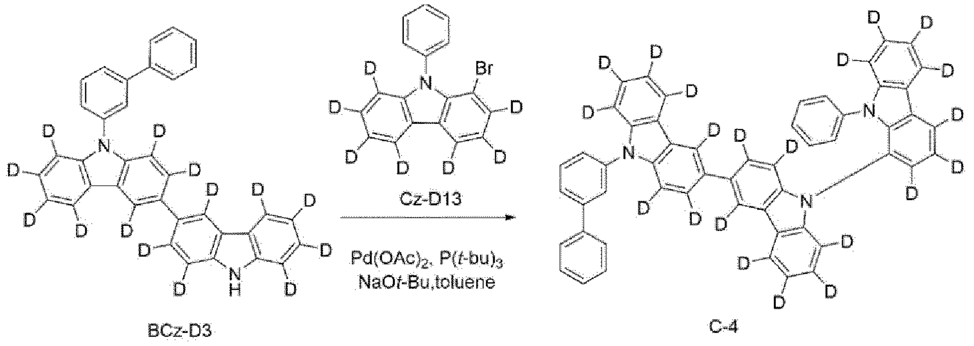


[0238] The same procedure as in Synthesis Example 21, with the exception of using Cz-D9 (7.9 g, 24.1 mmol) obtained in Preparation Example 3-1 instead of Cz-D1, was conducted to afford the target compound C-3 (11.67 g, yield 66%).

[0239] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 24] C-4

[0240]

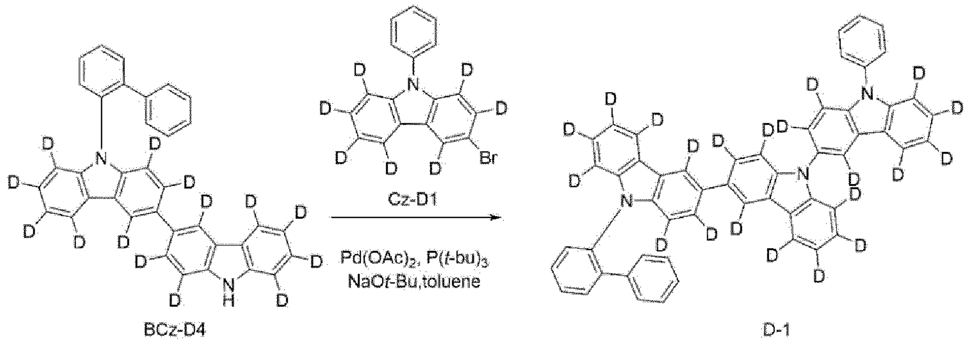


[0241] The same procedure as in Synthesis Example 21, with the exception of using Cz-D13 (7.9 g, 24.1 mmol) obtained in Preparation Example 4-1 instead of Cz-D1, was conducted to afford the target compound C-4 (6.89 g, yield 39%).

[0242] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 25] Synthesis of D-1

[0243]

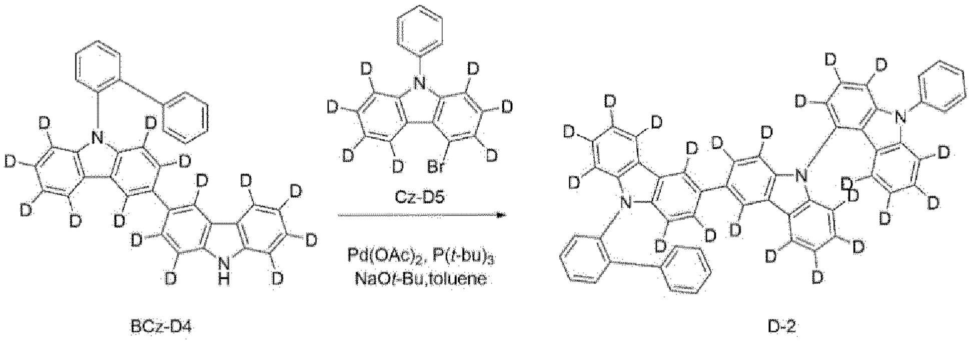


[0244] Under a nitrogen atmosphere, BCz-D4 (10.0 g, 20.1 mmol) obtained in Preparation Example 5-4, Cz-D1 (7.9 g, 24.1 mmol) obtained in Preparation Example 1-1, Pd(OAc)$_2$ (1.15 g, 1.0 mmol), P(t-Bu)$_3$ (0.49 ml, 2.0 mmol), NaO(t-Bu) (3.85 g, 40.1 mmol), and toluene (100 ml) were mixed and stirred at 110°C for 5 hours. After completion of the reaction, the toluene was concentrated and the solid salt was filtered, followed by filtration through recrystallization to afford the target compound D-1 (8.1 g, yield 54%).

[0245] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 26] Synthesis of D-2

[0246]

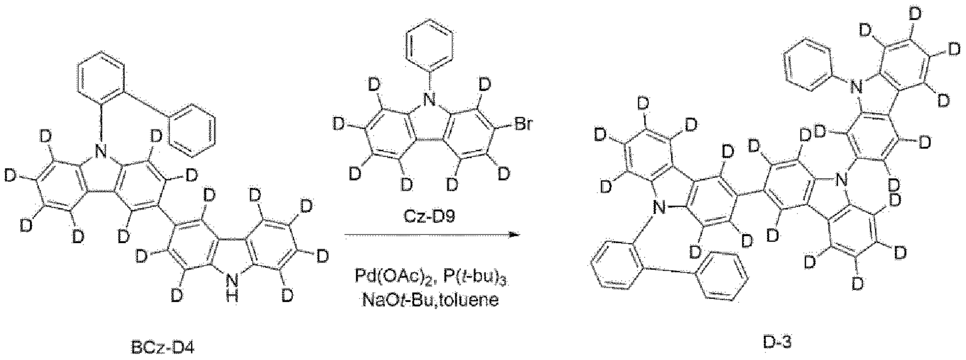


[0247] The same procedure as in Synthesis Example 25, with the exception of using Cz-D5 (7.9 g, 24.1 mmol) obtained in Preparation Example 2-1 instead of Cz-D1, was conducted to afford the target compound D-2 (7.24 g, yield 41%).

[0248] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 27] Synthesis of D-3

[0249]

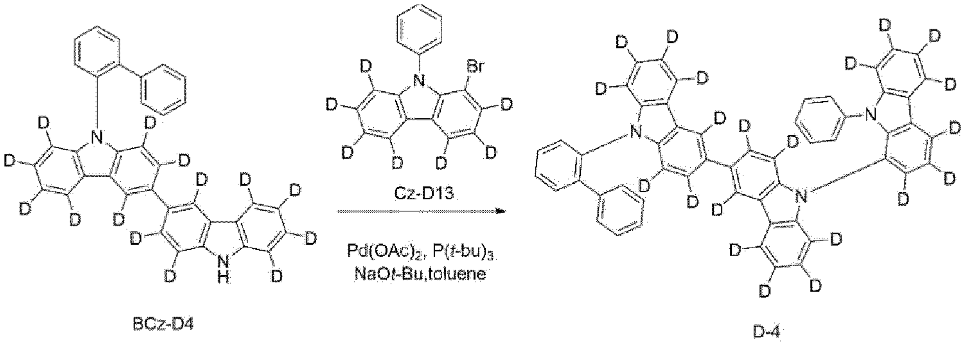


[0250] The same procedure as in Synthesis Example 25, with the exception of using Cz-D9 (7.9 g, 24.1 mmol) obtained in Preparation Example 3-1 instead of Cz-D1, was conducted to afford the target compound D-3 (8.41 g, yield 51%).

[0251] Mass (Calcd.: 747.02, Found: 747 g/mol)

[SYNTHESIS EXAMPLE 28] Synthesis of D-4

[0252]



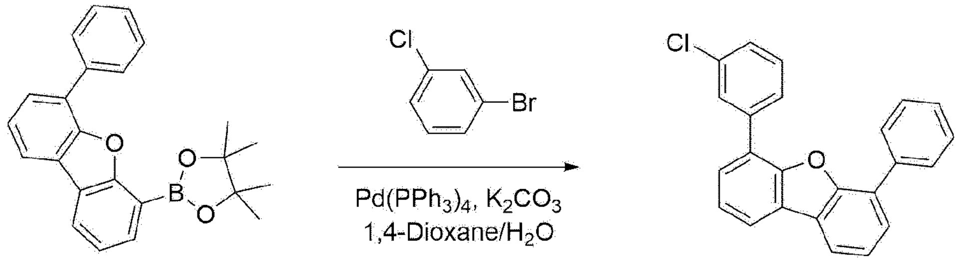
[0253] The same procedure as in Synthesis Example 25, with the exception of using Cz-D13 (7.9 g, 24.1 mmol) obtained in Preparation Example 4-1 instead of Cz-D1, was conducted to afford the target compound D-4 (5.47 g, yield 31%).

[0254] Mass (Calcd.: 747.02, Found: 747 g/mol)

[PREPARATION EXAMPLE 6] Synthesis of DBF-1

<Step 1> Synthesis of 4-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan

[0255]



[0256] Under a nitrogen atmosphere, 4,4,5,5-tetramethyl-2-(6-phenyldibenzo[b,d]furan-4-yl)-1,3,2-dioxaborolane (100.0 g, 270.0 mmol), 1-bromo-3-chlorobenzene (62.0 g, 324.1 mmol), $Pd(PPh_3)_4$ (15.6 g, 13.5 mmol), K_2CO_3 (93.3

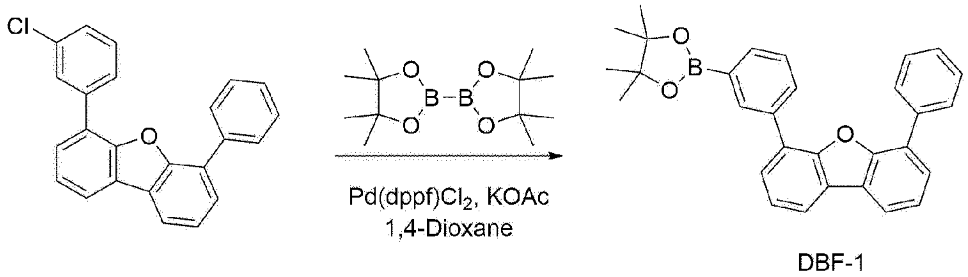
g, 675.2 mmol), and 1,4-dioxane/H_2O (1000 ml/250 ml) were mixed and stirred at 120°C for 4 hours.

[0257] After completion of the reaction, the reaction mixture was subjected to extraction with methylene chloride and the extract was added with $MgSO_4$ and filtered. The solvent was removed from the organic layer thus obtained, followed by purification by column chromatography (Hexane:DCM = 9:1 (v/v)) to afford 4-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan (48.9 g, yield 51%).

[0258] Mass (Calcd.: 354.83, Found: 354 g/mol)

<Step 2> Synthesis of DBF-1

[0259]



[0260] Under a nitrogen atmosphere, 4-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan (48.9 g, 137.7 mmol) obtained in <step 1>, 4,4,4',4',5,5, 5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (38.5 g, 151.5 mmol), Pd(dppf)Cl_2 (12.1 g, 13.8 mmol), KOAc (38.9 g, 413.2 mmol), and 1,4-Dioxane (1000 ml) were mixed and stirred at 130°C for 12 hours.

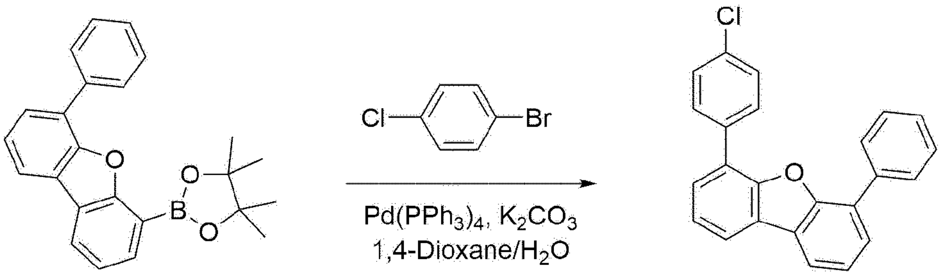
[0261] After completion of the reaction, the reaction mixture was subjected to extraction with ethyl acetate and the extract was dried over $MgSO_4$. Purification by column chromatography (Hexane:DCM = 4:1 (v/v)) to afford DBF-1 (26.4 g, yield 43%).

[0262] Mass (Calcd.: 446.35, Found: 446 g/mol)

[PREPARATION EXAMPLE 7] Synthesis of DBF-2

<Step 1> Synthesis of 4-(4-chlorophenyl)-6-phenyldibenzo[b,d]furan

[0263]



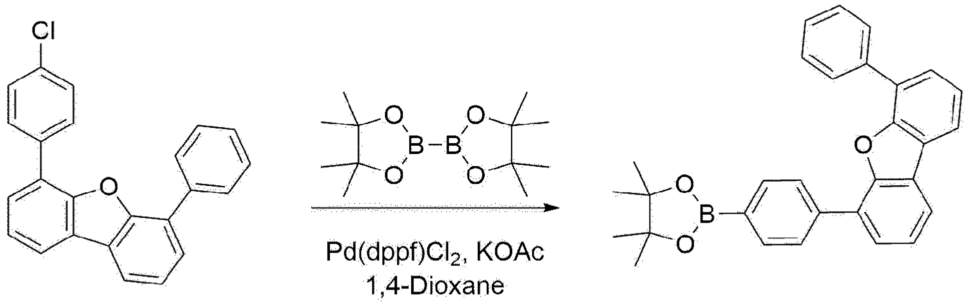
[0264] Under a nitrogen atmosphere, 4,4,5,5-tetramethyl-2-(6-phenyldibenzo[b,d]furan-4-yl)-1,3,2-dioxaborolane (100.0 g, 270.0 mmol), 1-bromo-4-chlorobenzene (62.0 g, 324.1 mmol), $Pd(PPh_3)_4$ (15.6 g, 13.5 mmol), K_2CO_3 (93.3 g, 675.2 mmol), and 1,4-dioxane/H_2O (1000 ml/250 ml) were mixed and stirred at 120°C for 4 hours.

[0265] After completion of the reaction, the reaction mixture was subjected to extraction with methylene chloride and the extract was added with $MgSO_4$ and filtered. The solvent was removed from the organic layer thus obtained, followed by purification by column chromatography (Hexane:DCM = 9:1 (v/v)) to afford 4-(4-chlorophenyl)-6-phenyldibenzo[b,d]furan (60.4 g, yield 63%) .

[0266] Mass (Calcd.: 354.83, Found: 354 g/mol)

<Step 2> Synthesis of DBF-2

[0267]



DBF-2

[0268] Under a nitrogen atmosphere, 4-(4-chlorophenyl)-6-phenyldibenzo[b,d]furan (60.4 g, 170.2 mmol) obtained in <step 1> , 4,4,4',4',5,5, 5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (47.5 g, 187.2 mmol), Pd(dppf)Cl_2 (14.9 g, 17.0 mmol), KOAc (48.1 g, 510.4 mmol), and 1,4-Dioxane (1000 ml) were mixed and stirred at 130°C for 12 hours.

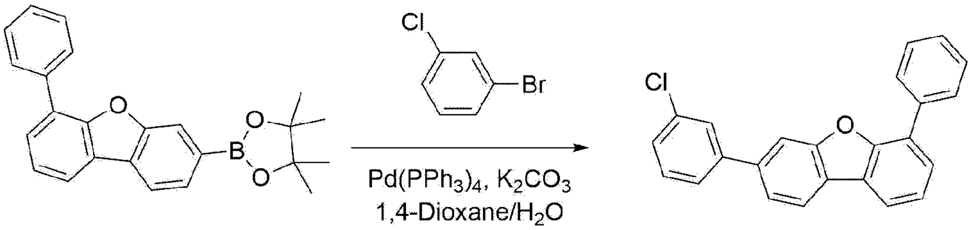
[0269] After completion of the reaction, the reaction mixture was subjected to extraction with ethyl acetate and the extract was dried over $MgSO_4$, followed by purification by column chromatography (Hexane:DCM = 4:1 (v/v)) to afford DBF-2 (36.5 g, yield 48%).

[0270] Mass (Calcd.: 446.35, Found: 446 g/mol)

[PREPARATION EXAMPLE 8] Synthesis of DBF-3

<Step 1> Synthesis of 3-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan

[0271]



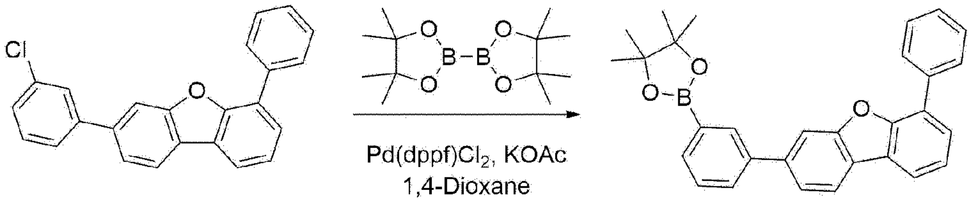
[0272] Under a nitrogen atmosphere, 4,4,5,5-tetramethyl-2-(6-phenyldibenzo[b,d]furan-3-yl)-1,3,2-dioxaborolane (100.0 g, 270.0 mmol), 1-bromo-3-chlorobenzene (62.0 g, 324.1 mmol), $Pd(PPh_3)_4$ (15.6 g, 13.5 mmol), K_2CO_3 (93.3 g, 675.2 mmol), and 1,4-dioxane/H_2O (1000 ml/250 ml) were mixed and stirred at 120°C for 4 hours.

[0273] After completion of the reaction, the reaction mixture was subjected to extraction with methylene chloride and the extract was added with $MgSO_4$ and filtered. The solvent was removed from the organic layer thus obtained, followed by purification by column chromatography (Hexane:DCM = 9:1 (v/v)) to afford 3-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan (68.0 g, yield 71%).

[0274] Mass (Calcd.: 354.83, Found: 354 g/mol)

<Step 2> Synthesis of DBF-3

[0275]



DBF-3

[0276] Under a nitrogen atmosphere, 3-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan (68.0 g, 191.8 mmol) obtained in <step 1>, 4,4,4',4',5,5, 5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (53.6 g, 210.9 mmol), Pd(dppf)Cl_2 (16.8 g, 19.2

mmol), KOAc (54.2 g, 575.3 mmol), and 1,4-Dioxane (1000 ml) were mixed and stirred at 130°C for 12 hours.

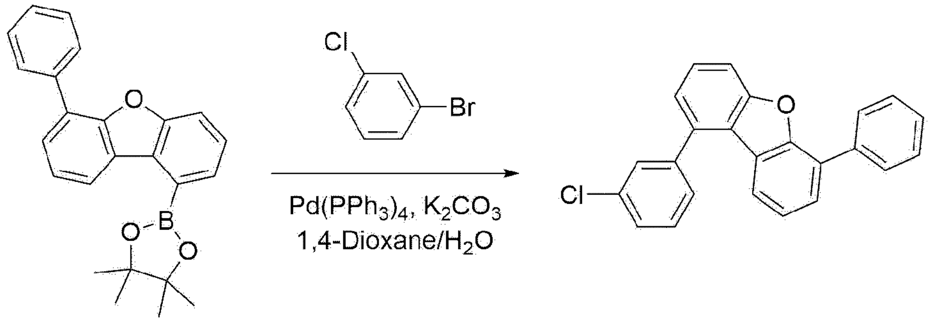
[0277] After completion of the reaction, the reaction mixture was subjected to extraction with ethyl acetate and the extract was dried over $MgSO_4$. Purification by column chromatography (Hexane: DCM = 4:1 (v/v)) to afford DBF-3 (54.8 g, yield 64%).

[0278] Mass (Calcd.: 446.35, Found: 446 g/mol)

[PREPARATION EXAMPLE 9] Synthesis of DBF-4

<Step 1> Synthesis of 1-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan

[0279]



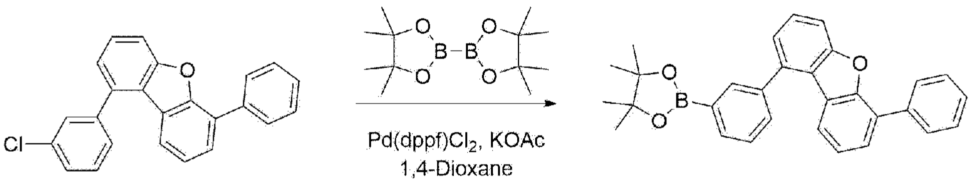
[0280] Under a nitrogen atmosphere, 4,4,5,5-tetramethyl-2-(6-phenyldibenzo[b,d]furan-1-yl)-1,3,2-dioxaborolane (100.0 g, 270.0 mmol), 1-bromo-3-chlorobenzene (62.0 g, 324.1 mmol), $Pd(PPh_3)_4$ (15.6 g, 13.5 mmol), K_2CO_3 (93.3 g, 675.2 mmol), and 1,4-dioxane/H_2O (1000 ml/250 ml) were mixed and stirred at 120°C for 4 hours.

[0281] After completion of the reaction, the reaction mixture was subjected to extraction with methylene chloride and the extract was added with $MgSO_4$ and filtered. The solvent was removed from the organic layer thus obtained, followed by purification by column chromatography (Hexane:DCM = 9:1 (v/v)) to afford 1-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan (62.3 g, yield 65%) .

[0282] Mass (Calcd.: 354.83, Found: 354 g/mol)

<Step 2> Synthesis of DBF-4

[0283]



DBF-4

[0284] Under a nitrogen atmosphere, 1-(3-chlorophenyl)-6-phenyldibenzo[b,d]furan (62.3 g, 175.6 mmol) obtained in <step 1>, 4,4,4',4',5,5, 5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (49.0 g, 193.1 mmol), $Pd(dppf)Cl_2$ (15.4 g, 17.6 mmol), KOAc (49.6 g, 526.7 mmol), and 1,4-Dioxane (1000 ml) were mixed and stirred at 130°C for 12 hours.

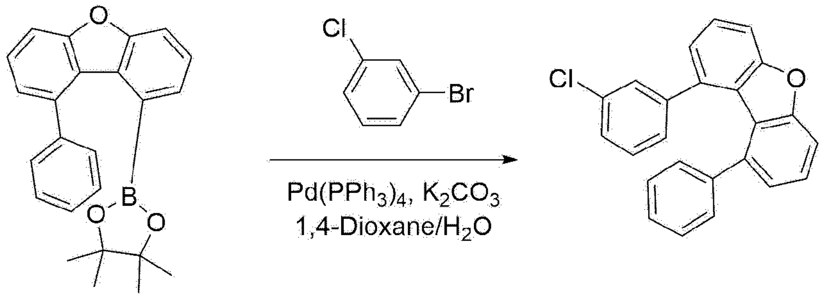
[0285] After completion of the reaction, the reaction mixture was subjected to extraction with ethyl acetate and the extract was dried over $MgSO_4$. Purification by column chromatography (Hexane:DCM = 4:1 (v/v)) afforded DBF-4 (45.4 g, yield 58%).

[0286] Mass (Calcd.: 446.35, Found: 446 g/mol)

[PREPARATION EXAMPLE 10] Synthesis of DBF-5

<Step 1> Synthesis of 1-(3-chlorophenyl)-9-phenyldibenzo[b,d]furan

[0287]



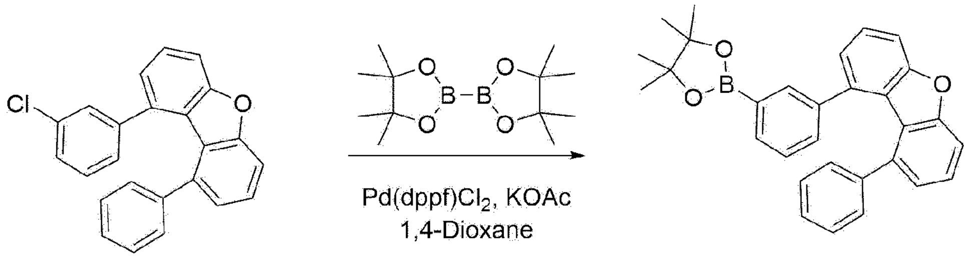
[0288] Under a nitrogen atmosphere, 4,4,5,5-tetramethyl-2-(9-phenyldibenzo[b,d]furan-1-yl)-1,3,2-dioxaborolane (100.0 g, 270.0 mmol), 1-bromo-3-chlorobenzene (62.0 g, 324.1 mmol), Pd(PPh$_3$)$_4$ (15.6 g, 13.5 mmol), K$_2$CO$_3$ (93.3 g, 675.2 mmol), and 1,4-dioxane/H$_2$O (1000 ml/250 ml) were mixed and stirred at 120°C for 4 hours.

[0289] After completion of the reaction, the reaction mixture was subjected to extraction with methylene chloride and the extract was added with MgSO$_4$ and filtered. The solvent was removed from the organic layer thus obtained, followed by purification by column chromatography (Hexane:DCM = 9:1 (v/v)) to afford 1-(3-chlorophenyl)-9-phenyldibenzo[b,d]furan (68.0 g, yield 71%).

[0290] Mass (Calcd.: 354.83, Found: 354 g/mol)

<Step 2> Synthesis of DBF-5

[0291]



DBF-5

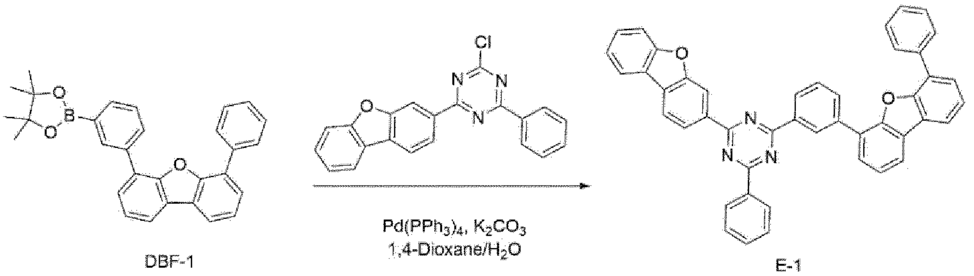
[0292] Under a nitrogen atmosphere, 1-(3-chlorophenyl)-9-phenyldibenzo[b,d]furan (68.0 g, 191.8 mmol) obtained in <step 1>, 4,4,4',4',5,5, 5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (53.6 g, 210.9 mmol), Pd(dppf)Cl$_2$ (16.8 g, 19.2 mmol), KOAc (54.2 g, 575.3 mmol), and 1,4-Dioxane (1000 ml) were mixed and stirred at 130°C for 12.

[0293] After completion of the reaction, the reaction mixture was subjected to extraction with ethyl acetate and the extract was dried over MgSO$_4$. Purification by column chromatography (Hexane:DCM = 4:1 (v/v)) afforded DBF-5 (41.9 g, yield 49%).

[0294] Mass (Calcd.: 446.35, Found: 446 g/mol)

[SYNTHESIS EXAMPLE 29] Synthesis of E-1

[0295]



DBF-1

E-1

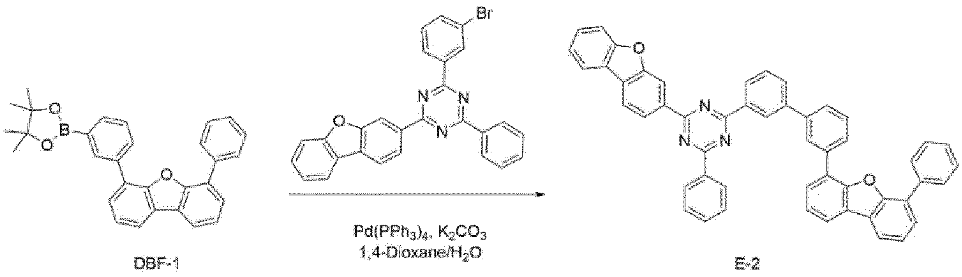
[0296] Under a nitrogen atmosphere, DBF-1 (10.0 g, 22.4 mmol) obtained in Preparation Example 6, 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine (9.6 g, 26.9 mmol), Pd(PPh$_3$)$_4$ (1.3 g, 1.1 mmol), K$_2$CO$_3$ (7.7 g, 56.0 mmol), and 1,4-dioxane/H_2O (1000 ml/250 ml) were mixed and stirred at 120°C for 4 hours.

[0297] After completion of the reaction, the reaction mixture was subjected to extraction with methylene chloride and the extract was added with $MgSO_4$ and filtered. The solvent was removed from the organic layer thus obtained, followed by purification by column chromatography (Hexane:EA = 4:1 (v/v)) to afford the target compound E-1 (11.8 g, yield 82%).

[0298] Mass (Calcd.: 641.73, Found: 641 g/mol)

[SYNTHESIS EXAMPLE 30] Synthesis of E-2

[0299]

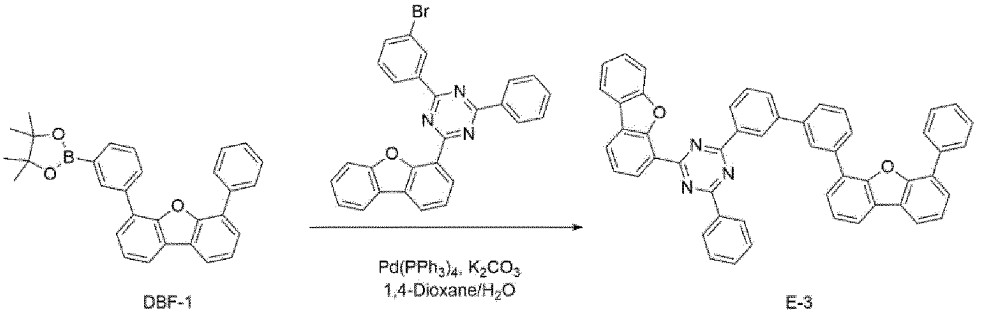


[0300] The same procedure as in Synthesis Example 29, with the exception of using 2-(3-bromophenyl)-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine (12.9 g, 26.9 mmol) instead of 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine, was conducted to afford the target compound E-2 (11.9 g, yield 74%).

[0301] Mass (Calcd.: 717.83, Found: 717 g/mol)

[SYNTHESIS EXAMPLE 31] Synthesis of E-3

[0302]

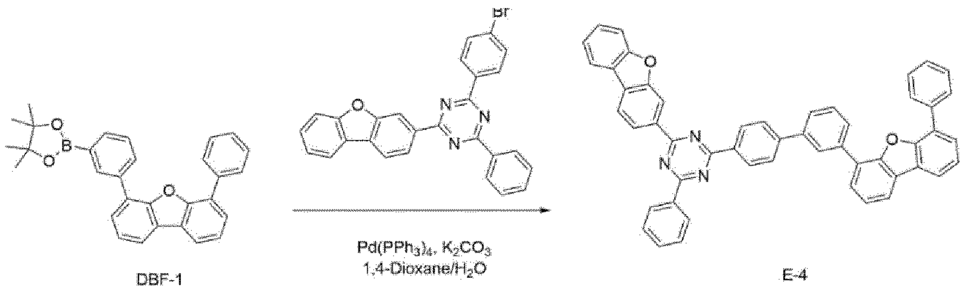


[0303] The same procedure as in Synthesis Example 29, with the exception of using 2-(3-bromophenyl)-4-(dibenzo[b,d]furan-4-yl)-6-phenyl-1,3,5-triazine (12.9 g, 26.9 mmol) instead of 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine, was conducted to afford the target compound E-3 (11.4 g, yield 71%).

[0304] Mass (Calcd.: 717.83, Found: 717 g/mol)

[SYNTHESIS EXAMPLE 32] Synthesis of E-4

[0305]

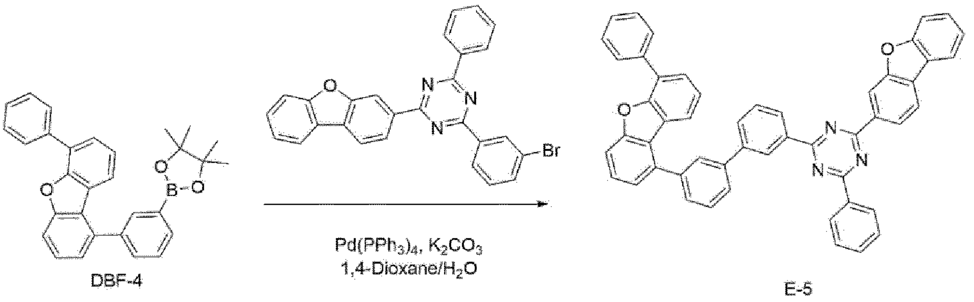


[0306] The same procedure as in Synthesis Example 29, with the exception of using 2-(4-bromophenyl)-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine (12.9 g, 26.9 mmol) instead of 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine, was conducted to afford the target compound E-4 (12.7 g, yield 79%).

[0307] Mass (Calcd.: 717.83, Found: 717 g/mol)

[SYNTHESIS EXAMPLE 33] Synthesis of E-5

[0308]

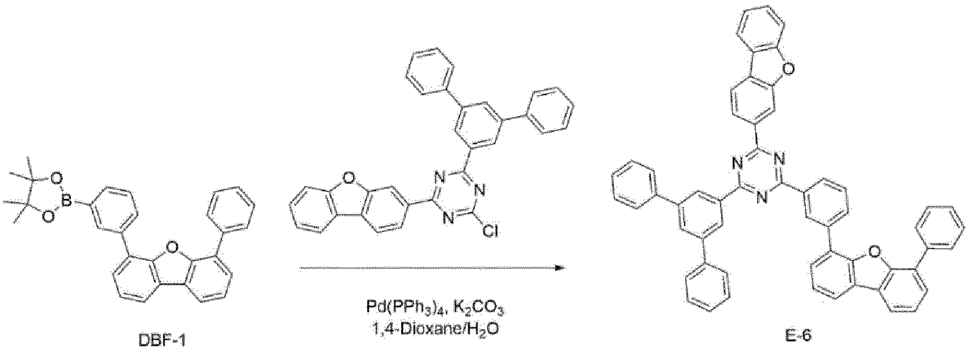


[0309] The same procedure as in Synthesis Example 29, with the exception of using DBF-4 (10.0 g, 22.4 mmol) obtained in Preparation Example 9 and 2-(3-bromophenyl)-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine (12.9 g, 26.9 mmol) instead of DBF-1 (10.0 g, 22.4 mmol) and 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine, respectively, was conducted to afford the target compound E-5 (9.8 g, yield 61%).

[0310] Mass (Calcd.: 717.83, Found: 717 g/mol)

[SYNTHESIS EXAMPLE 34] Synthesis of E-6

[0311]

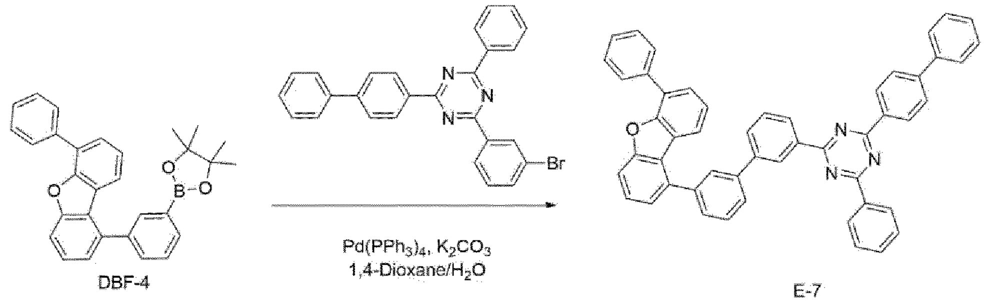


[0312] The same procedure as in Synthesis Example 29, with the exception of using 2-([1,1':3',1''-terphenyl]-5'-yl)-4-chloro-6-(dibenzo[b,d]furan-3-yl)-1,3,5-triazine (13.7 g, 26.9 mmol) instead of 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine, was conducted to afford the target compound E-6 (9.6 g, yield 54%).

[0313] Mass (Calcd.: 793.93, Found: 793 g/mol)

[SYNTHESIS EXAMPLE 35] Synthesis of E-7

[0314]

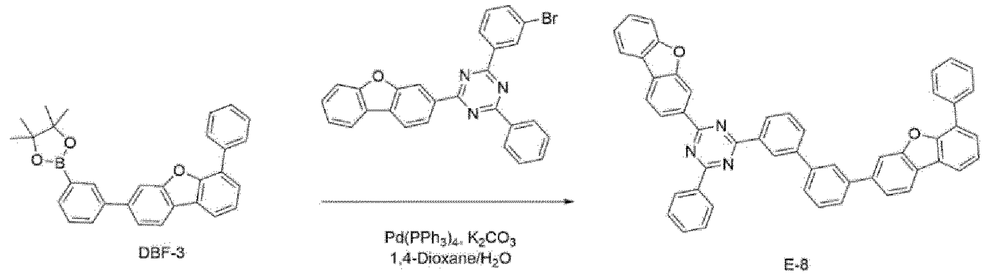


[0315] The same procedure as in Synthesis Example 29, with the exception of using DBF-4 (10.0 g, 22.4 mmol) obtained in Preparation Example 9 and 2-([1,1'-biphenyl]-4-yl)-4-(3-bromophenyl)-6-phenyl-1,3,5-triazine (12.5 g, 26.9 mmol) instead of DBF-1 (10.0 g, 22.4 mmol) and 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine, respectively, was conducted to afford the target compound E-7 (9.8 g, yield 62%).

[0316] Mass (Calcd.: 703.85, Found: 703 g/mol)

[SYNTHESIS EXAMPLE 36] Synthesis of E-8

[0317]

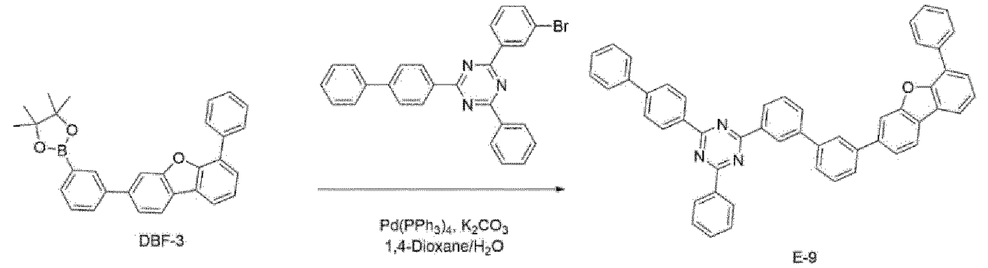


[0318] The same procedure as in Synthesis Example 29, with the exception of using DBF-3 (10.0 g, 22.4 mmol) obtained in Preparation Example 8 and 2-(3-bromophenyl)-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine (12.9 g, 26.9 mmol) instead of DBF-1 (10.0 g, 22.4 mmol) and 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine, was conducted to afford the target compound E-8 (10.8 g, yield 67%).

[0319] Mass (Calcd.: 717.83, Found: 717 g/mol)

[SYNTHESIS EXAMPLE 37] Synthesis of E-9

[0320]

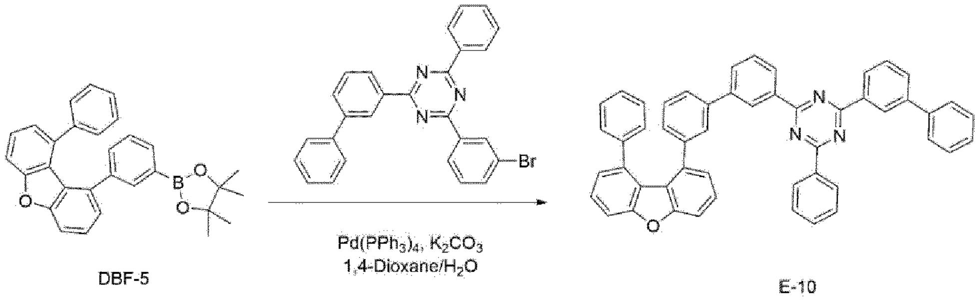


[0321] The same procedure as in Synthesis Example 29, with the exception of using DBF-3 (10.0 g, 22.4 mmol) obtained in Preparation Example 8 and 2-([1,1'-biphenyl]-4-yl)-4-(3-bromophenyl)-6-phenyl-1,3,5-triazine (12.5 g, 26.9 mmol) instead of DBF-1 (10.0 g, 22.4 mmol) and 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-henyl-1,3,5-triazine, respectively, was conducted to afford the target compound E-9 (11.4 g, yield 72%).

[0322] Mass (Calcd.: 703.85, Found: 703 g/mol)

[SYNTHESIS EXAMPLE 38] Synthesis of E-10

[0323]



[0324] The same procedure as in Synthesis Example 29, with the exception of using DBF-5 (10.0 g, 22.4 mmol) obtained in Preparation Example and 2-([1,1'-biphenyl]-3-yl)-4-(3-bromophenyl)-6-phenyl-1,3,5-triazine (12.5 g, 26.9 mmol) instead of DBF-1 (10.0 g, 22.4 mmol) and 2-chloro-4-(dibenzo[b,d]furan-3-yl)-6-phenyl-1,3,5-triazine, respectively, was conducted to afford the target compound E-10 (10.4 g, yield 66%).

[0325] Mass (Calcd.: 703.85, Found: 703 g/mol)

[EXAMPLE 1] - Preparation of Pellet P1 and

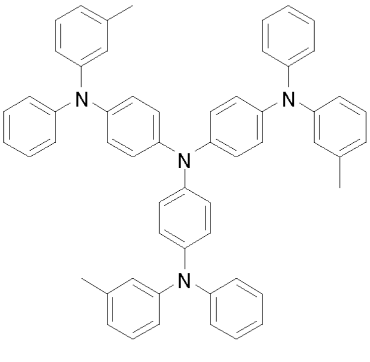
Fabrication of Green Organic EL Device

[0326] Compound A-1 with hole characteristics and compound E-1 with electron characteristic were uniformly mixed at a 6:4 weight ratio, and then the mixture was pelletized under a pressure of 20,000 kgf/cm^2 to obtain pellet P1, as shown in FIG. 1(a). Using this pellet, a green organic EL device was fabricated as described below. In this regard, compound A-1 with hole characteristics was synthesized in Synthesis Example 1, and compound E-1 with electron characteristics was synthesized in Synthesis Example 29.

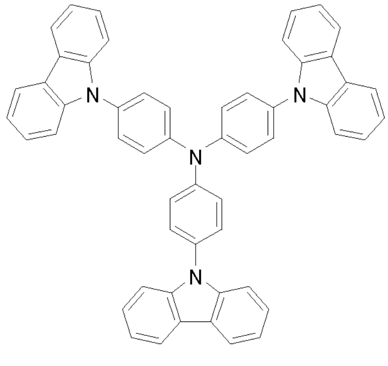
[0327] First, a glass substrate coated with indium tin oxide (ITO) 1500 Å thick was cleansed using ultrasonic waves in distilled water. After the distilled water cleansing, the substrate was ultrasonically cleansed using solvents such as isopropyl alcohol, acetone, and methanol, dried, and transferred to a UV OZONE cleaner (Power Sonic 405, Hwashin Tech), where it was treated with UV for 5 minutes. The cleaned substrate was then transferred to a vacuum deposition system.

[0328] On the prepared ITO transparent electrode, the following layers were sequentially deposited: m-MTDATA (60 nm)/TCTA (80 nm)/90 wt% Pellet P1 + 10 wt% Ir(ppy)$_3$ (300 nm)/BCP (10 nm)/Alq$_3$ (30 nm)/LiF (1 nm) /Al (200 nm), thereby fabricating the organic EL device.

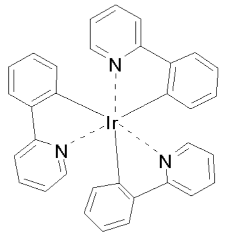
[0329] The structures of m-MTDATA, TCTA, Ir(ppy)$_3$, and BCP are as follows:



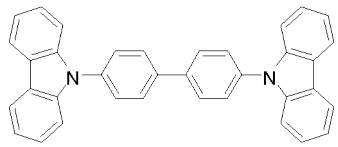
m-MTDATA



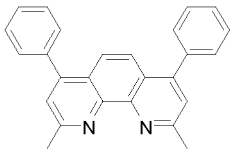
TCTA



Ir(ppy)3



CBP



BCP

[EXAMPLES 2 TO 280] - Preparation of Pellets P2 to P280 and Fabrication of Green Organic EL Devices

[0330] The same procedure as in Example 1, with the exception of using compounds A-2 to D-4 listed in Table 2, instead of compound A-1, as the first organic compound and compounds E-2 to E-10 listed in Table 2, instead of compound E-1, as the second compound, was conducted to prepare pellets P2 to P280 and fabricate green organic EL devices. In this regard, the mixing ratio of the first and second organic compounds was the same as that of compound A-1 and compound E-1 in Example 1.

[EXAMPLES 2 TO 280] - Preparation of Pellet P281 and Fabrication of Green Organic EL Device

[0331] The same procedure as in Example 1, with the exception of mixing compounds A-1 and E-1 at a weight ratio of 5:5, to prepare pellet P281, and a green organic EL device was fabricated using same.

[EXAMPLE 3] - Preparation of Pellet P282 and Fabrication of Green Organic EL Device

[0332] The same procedure as in Example 1, with the exception of mixing compounds A-1 and E-1 at a weight ratio of 7:3, to prepare pellet P282, and a green organic EL device was fabricated using same.

[COMPARATIVE EXAMPLE 1] - Fabrication of Green Organic EL Device

[0333] The same procedure as in Example 1, with the exception of using a simple mixture comA-1 of compounds A-1 and E-1 (compound A-1 : compound E-1 = 6:4 weight ratio) instead of pellet P1, was conducted to fabricate a green organic EL device. In this regard, unlike pellet P1, the simple mixture comA-1 was a uniform mixture of compounds A-1 and E-1 without being compressed into a pellet under high pressure. The compounds A-1 and E-1 used were the same as those described in Example 1.

[COMPARATIVE EXAMPLE 2] - Fabrication of Green Organic EL Device

[0334] The same procedure as in Comparative Example 1, with the exception of mixing using compounds A-1 and E-1 at a weight ratio of 5:5, to prepare a simple mixture comB, and a green organic EL device was fabricated using same.

[COMPARATIVE EXAMPLE 3] - Fabrication of Green Organic EL Device

[0335] The same procedure as in Example 1, with the exception of mixing compounds A-1 and E-1 at a weight ratio of 7:3, to prepare a simple mixture comC, and a green organic EL device was fabricated using same.

[EXPERIMENTAL EXAMPLE 1] - Measurement of Maximum Emission Wavelength of Pellets

[0336] Pellets P1 to P280, prepared in Examples 1 to 280, were made into films, and their maximum emission wavelengths were measured. The results are given in Table 1. In this regard, the maximum emission wavelengths of the raw materials (compounds A-1 to D-4 and compounds E-1 to E-10) used for each pellet were also measured, and for comparison, the maximum emission wavelength of the simple mixture comA in Comparative Example 1 was measured as the control.

TABLE 1

	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)
Ex. 1	A-1	380	E-1	415	Pellet P1	415
Ex. 2	A-1	380	E-2	415	Pellet P2	415
Ex. 3	A-1	380	E-3	414	Pellet P3	414
Ex. 4	A-1	380	E-4	416	Pellet P4	416
Ex. 5	A-1	380	E-5	419	Pellet P5	419
Ex. 6	A-1	380	E-6	413	Pellet P6	413
Ex. 7	A-1	380	E-7	414	Pellet P7	414
Ex. 8	A-1	380	E-8	415	Pellet P8	415
Ex. 9	A-1	380	E-9	415	Pellet P9	415
Ex. 10	A-1	380	E-10	416	Pellet P10	416
Ex. 11	A-2	378	E-1	415	Pellet P11	415
Ex. 12	A-2	378	E-2	415	Pellet P12	415
Ex. 13	A-2	378	E-3	414	Pellet P13	414
Ex. 14	A-2	378	E-4	416	Pellet P14	416
Ex. 15	A-2	378	E-5	419	Pellet P15	419
Ex. 16	A-2	378	E-6	413	Pellet P16	413
Ex. 17	A-2	378	E-7	414	Pellet P17	414
Ex. 18	A-2	378	E-8	415	Pellet P18	415
Ex. 19	A-2	378	E-9	415	Pellet P19	415
Ex. 20	A-2	378	E-10	416	Pellet P20	416
Ex. 21	A-3	377	E-1	415	Pellet P21	415
Ex. 22	A-3	377	E-2	415	Pellet P22	415
Ex. 23	A-3	377	E-3	414	Pellet P23	414
Ex. 24	A-3	377	E-4	416	Pellet P24	416
Ex. 25	A-3	377	E-5	419	Pellet P25	419
Ex. 26	A-3	377	E-6	413	Pellet P26	413
Ex. 27	A-3	377	E-7	414	Pellet P27	414
Ex. 28	A-3	377	E-8	415	Pellet P28	415
Ex. 29	A-3	377	E-9	415	Pellet P29	415
Ex. 30	A-3	377	E-10	416	Pellet P30	416
Ex. 31	A-4	380	E-1	415	Pellet P31	415
Ex. 32	A-4	380	E-2	415	Pellet P32	415
Ex. 33	A-4	380	E-3	414	Pellet P33	414
Ex. 34	A-4	380	E-4	416	Pellet P34	416
Ex. 35	A-4	380	E-5	419	Pellet P35	419
Ex. 36	A-4	380	E-6	413	Pellet P36	413
Ex. 37	A-4	380	E-7	414	Pellet P37	414
Ex. 38	A-4	380	E-8	415	Pellet P38	415

(continued)

	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)
Ex. 39	A-4	380	E-9	415	Pellet P39	415
Ex. 40	A-4	380	E-10	416	Pellet P40	416
Ex. 41	A-5	382	E-1	415	Pellet P41	415
Ex. 42	A-5	382	E-2	415	Pellet P42	415
Ex. 43	A-5	382	E-3	414	Pellet P43	414
Ex. 44	A-5	382	E-4	416	Pellet P44	416
Ex. 45	A-5	382	E-5	419	Pellet P45	419
Ex. 46	A-5	382	E-6	413	Pellet P46	413
Ex. 47	A-5	382	E-7	414	Pellet P47	414
Ex. 48	A-5	382	E-8	415	Pellet P48	415
Ex. 49	A-5	382	E-9	415	Pellet P49	415
Ex. 50	A-5	382	E-10	416	Pellet P50	416
Ex. 51	A-6	376	E-1	415	Pellet P51	415
Ex. 52	A-6	376	E-2	415	Pellet P52	415
Ex. 53	A-6	376	E-3	414	Pellet P53	414
Ex. 54	A-6	376	E-4	416	Pellet P54	416
Ex. 55	A-6	376	E-5	419	Pellet P55	419
Ex. 56	A-6	376	E-6	413	Pellet P56	413
Ex. 57	A-6	376	E-7	414	Pellet P57	414
Ex. 58	A-6	376	E-8	415	Pellet P58	415
Ex. 59	A-6	376	E-9	415	Pellet P59	415
Ex. 60	A-6	376	E-10	416	Pellet P60	416
Ex. 61	A-7	381	E-1	415	Pellet P61	415
Ex. 62	A-7	381	E-2	415	Pellet P62	415
Ex. 63	A-7	381	E-3	414	Pellet P63	414
Ex. 64	A-7	381	E-4	416	Pellet P64	416
Ex. 65	A-7	381	E-5	419	Pellet P65	419
Ex. 66	A-7	381	E-6	413	Pellet P66	413
Ex. 67	A-7	381	E-7	414	Pellet P67	414
Ex. 68	A-7	381	E-8	415	Pellet P68	415
Ex. 69	A-7	381	E-9	415	Pellet P69	415
Ex. 70	A-7	381	E-10	416	Pellet P70	416
Ex. 71	A-8	381	E-1	415	Pellet P71	415
Ex. 72	A-8	381	E-2	415	Pellet P72	415
Ex. 73	A-8	381	E-3	414	Pellet P73	414
Ex. 74	A-8	381	E-4	416	Pellet P74	416
Ex. 75	A-8	381	E-5	419	Pellet P75	419
Ex. 76	A-8	381	E-6	413	Pellet P76	413

(continued)

	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)
Ex. 77	A-8	381	E-7	414	Pellet P77	414
Ex. 78	A-8	381	E-8	415	Pellet P78	415
Ex. 79	A-8	381	E-9	415	Pellet P79	415
Ex. 80	A-8	381	E-10	416	Pellet P80	416
Ex. 81	A-9	381	E-1	415	Pellet P81	415
Ex. 82	A-9	381	E-2	415	Pellet P82	415
Ex. 83	A-9	381	E-3	414	Pellet P83	414
Ex. 84	A-9	381	E-4	416	Pellet P84	416
Ex. 85	A-9	381	E-5	419	Pellet P85	419
Ex. 86	A-9	381	E-6	413	Pellet P86	413
Ex. 87	A-9	381	E-7	414	Pellet P87	414
Ex. 88	A-9	381	E-8	415	Pellet P88	415
Ex. 89	A-9	381	E-9	415	Pellet P89	415
Ex. 90	A-9	381	E-10	416	Pellet P90	416
Ex. 91	A-10	378	E-1	415	Pellet P91	415
Ex. 92	A-10	378	E-2	415	Pellet P92	415
Ex. 93	A-10	378	E-3	414	Pellet P93	414
Ex. 94	A-10	378	E-4	416	Pellet P94	416
Ex. 95	A-10	378	E-5	419	Pellet P95	419
Ex. 96	A-10	378	E-6	413	Pellet P96	413
Ex. 97	A-10	378	E-7	414	Pellet P97	414
Ex. 98	A-10	378	E-8	415	Pellet P98	415
Ex. 99	A-10	378	E-9	415	Pellet P99	415
Ex. 100	A-10	378	E-10	416	Pellet P100	416
Ex. 101	A-11	381	E-1	415	Pellet P101	415
Ex. 102	A-11	381	E-2	415	Pellet P102	415
Ex. 103	A-11	381	E-3	414	Pellet P103	414
Ex. 104	A-11	381	E-4	416	Pellet P104	416
Ex. 105	A-11	381	E-5	419	Pellet P105	419
Ex. 106	A-11	381	E-6	413	Pellet P106	413
Ex. 107	A-11	381	E-7	414	Pellet P107	414
Ex. 108	A-11	381	E-8	415	Pellet P108	415
Ex. 109	A-11	381	E-9	415	Pellet P109	415
Ex. 110	A-11	381	E-10	416	Pellet P110	416
Ex. 111	A-12	384	E-1	415	Pellet P111	415
Ex. 112	A-12	384	E-2	415	Pellet P112	415
Ex. 113	A-12	384	E-3	414	Pellet P113	414
Ex. 114	A-12	384	E-4	416	Pellet P114	416

(continued)

	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)
Ex. 115	A-12	384	E-5	419	Pellet P115	419
Ex. 116	A-12	384	E-6	413	Pellet P116	413
Ex. 117	A-12	384	E-7	414	Pellet P117	414
Ex. 118	A-12	384	E-8	415	Pellet P118	415
Ex. 119	A-12	384	E-9	415	Pellet P119	415
Ex. 120	A-12	384	E-10	416	Pellet P120	416
Ex. 121	A-13	383	E-1	415	Pellet P121	415
Ex. 122	A-13	383	E-2	415	Pellet P122	415
Ex. 123	A-13	383	E-3	414	Pellet P123	414
Ex. 124	A-13	383	E-4	416	Pellet P124	416
Ex. 125	A-13	383	E-5	419	Pellet P125	419
Ex. 126	A-13	383	E-6	413	Pellet P126	413
Ex. 127	A-13	383	E-7	414	Pellet P127	414
Ex. 128	A-13	383	E-8	415	Pellet P128	415
Ex. 129	A-13	383	E-9	415	Pellet P129	415
Ex. 130	A-13	383	E-10	416	Pellet P130	416
Ex. 131	A-14	378	E-1	415	Pellet P131	415
Ex. 132	A-14	378	E-2	415	Pellet P132	415
Ex. 133	A-14	378	E-3	414	Pellet P133	414
Ex. 134	A-14	378	E-4	416	Pellet P134	416
Ex. 135	A-14	378	E-5	419	Pellet P135	419
Ex. 136	A-14	378	E-6	413	Pellet P136	413
Ex. 137	A-14	378	E-7	414	Pellet P137	414
Ex. 138	A-14	378	E-8	415	Pellet P138	415
Ex. 139	A-14	378	E-9	415	Pellet P139	415
Ex. 140	A-14	378	E-10	416	Pellet P140	416
Ex. 141	A-15	377	E-1	415	Pellet P141	415
Ex. 142	A-15	377	E-2	415	Pellet P142	415
Ex. 143	A-15	377	E-3	414	Pellet P143	414
Ex. 144	A-15	377	E-4	416	Pellet P144	416
Ex. 145	A-15	377	E-5	419	Pellet P145	419
Ex. 146	A-15	377	E-6	413	Pellet P146	413
Ex. 147	A-15	377	E-7	414	Pellet P147	414
Ex. 148	A-15	377	E-8	415	Pellet P148	415
Ex. 149	A-15	377	E-9	415	Pellet P149	415
Ex. 150	A-15	377	E-10	416	Pellet P150	416
Ex. 151	A-16	384	E-1	415	Pellet P151	415
Ex. 152	A-16	384	E-2	415	Pellet P152	415

(continued)

	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)
Ex. 153	A-16	384	E-3	414	Pellet P153	414
Ex. 154	A-16	384	E-4	416	Pellet P154	416
Ex. 155	A-16	384	E-5	419	Pellet P155	419
Ex. 156	A-16	384	E-6	413	Pellet P156	413
Ex. 157	A-16	384	E-7	414	Pellet P157	414
Ex. 158	A-16	384	E-8	415	Pellet P158	415
Ex. 159	A-16	384	E-9	415	Pellet P159	415
Ex. 160	A-16	384	E-10	416	Pellet P160	416
Ex. 161	B-1	379	E-1	415	Pellet P161	415
Ex. 162	B-1	379	E-2	415	Pellet P162	415
Ex. 163	B-1	379	E-3	414	Pellet P163	414
Ex. 164	B-1	379	E-4	416	Pellet P164	416
Ex. 165	B-1	379	E-5	419	Pellet P165	419
Ex. 166	B-1	379	E-6	413	Pellet P166	413
Ex. 167	B-1	379	E-7	414	Pellet P167	414
Ex. 168	B-1	379	E-8	415	Pellet P168	415
Ex. 169	B-1	379	E-9	415	Pellet P169	415
Ex. 170	B-1	379	E-10	416	Pellet P170	416
Ex. 171	B-2	379	E-1	415	Pellet P171	415
Ex. 172	B-2	379	E-2	415	Pellet P172	415
Ex. 173	B-2	379	E-3	414	Pellet P173	414
Ex. 174	B-2	379	E-4	416	Pellet P174	416
Ex. 175	B-2	379	E-5	419	Pellet P175	419
Ex. 176	B-2	379	E-6	413	Pellet P176	413
Ex. 177	B-2	379	E-7	414	Pellet P177	414
Ex. 178	B-2	379	E-8	415	Pellet P178	415
Ex. 179	B-2	379	E-9	415	Pellet P179	415
Ex. 180	B-2	379	E-10	416	Pellet P180	416
Ex. 181	B-3	380	E-1	415	Pellet P181	415
Ex. 182	B-3	380	E-2	415	Pellet P182	415
Ex. 183	B-3	380	E-3	414	Pellet P183	414
Ex. 184	B-3	380	E-4	416	Pellet P184	416
Ex. 185	B-3	380	E-5	419	Pellet P185	419
Ex. 186	B-3	380	E-6	413	Pellet P186	413
Ex. 187	B-3	380	E-7	414	Pellet P187	414
Ex. 188	B-3	380	E-8	415	Pellet P188	415
Ex. 189	B-3	380	E-9	415	Pellet P189	415
Ex. 190	B-3	380	E-10	416	Pellet P190	416

(continued)

	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)
Ex. 191	B-4	382	E-1	415	Pellet P191	415
Ex. 192	B-4	382	E-2	415	Pellet P192	415
Ex. 193	B-4	382	E-3	414	Pellet P193	414
Ex. 194	B-4	382	E-4	416	Pellet P194	416
Ex. 195	B-4	382	E-5	419	Pellet P195	419
Ex. 196	B-4	382	E-6	413	Pellet P196	413
Ex. 197	B-4	382	E-7	414	Pellet P197	414
Ex. 198	B-4	382	E-8	415	Pellet P198	415
Ex. 199	B-4	382	E-9	415	Pellet P199	415
Ex. 200	B-4	382	E-10	416	Pellet P200	416
Ex. 201	C-1	381	E-1	415	Pellet P201	415
Ex. 202	C-1	381	E-2	415	Pellet P202	415
Ex. 203	C-1	381	E-3	414	Pellet P203	414
Ex. 204	C-1	381	E-4	416	Pellet P204	416
Ex. 205	C-1	381	E-5	419	Pellet P205	419
Ex. 206	C-1	381	E-6	413	Pellet P206	413
Ex. 207	C-1	381	E-7	414	Pellet P207	414
Ex. 208	C-1	381	E-8	415	Pellet P208	415
Ex. 209	C-1	381	E-9	415	Pellet P209	415
Ex. 210	C-1	381	E-10	416	Pellet P210	416
Ex. 211	C-2	382	E-1	415	Pellet P211	415
Ex. 212	C-2	382	E-2	415	Pellet P212	415
Ex. 213	C-2	382	E-3	414	Pellet P213	414
Ex. 214	C-2	382	E-4	416	Pellet P214	416
Ex. 215	C-2	382	E-5	419	Pellet P215	419
Ex. 216	C-2	382	E-6	413	Pellet P216	413
Ex. 217	C-2	382	E-7	414	Pellet P217	414
Ex. 218	C-2	382	E-8	415	Pellet P218	415
Ex. 219	C-2	382	E-9	415	Pellet P219	415
Ex. 220	C-2	382	E-10	416	Pellet P220	416
Ex. 221	C-3	381	E-1	415	Pellet P221	415
Ex. 222	C-3	381	E-2	415	Pellet P222	415
Ex. 223	C-3	381	E-3	414	Pellet P223	414
Ex. 224	C-3	381	E-4	416	Pellet P224	416
Ex. 225	C-3	381	E-5	419	Pellet P225	419
Ex. 226	C-3	381	E-6	413	Pellet P226	413
Ex. 227	C-3	381	E-7	414	Pellet P227	414
Ex. 228	C-3	381	E-8	415	Pellet P228	415

(continued)

	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)
Ex. 229	C-3	381	E-9	415	Pellet P229	415
Ex. 230	C-3	381	E-10	416	Pellet P230	416
Ex. 231	C-4	385	E-1	415	Pellet P231	415
Ex. 232	C-4	385	E-2	415	Pellet P232	415
Ex. 233	C-4	385	E-3	414	Pellet P233	414
Ex. 234	C-4	385	E-4	416	Pellet P234	416
Ex. 235	C-4	385	E-5	419	Pellet P235	419
Ex. 236	C-4	385	E-6	413	Pellet P236	413
Ex. 237	C-4	385	E-7	414	Pellet P237	414
Ex. 238	C-4	385	E-8	415	Pellet P238	415
Ex. 239	C-4	385	E-9	415	Pellet P239	415
Ex. 240	C-4	385	E-10	416	Pellet P240	416
Ex. 241	D-1	379	E-1	415	Pellet P241	415
Ex. 242	D-1	379	E-2	415	Pellet P242	415
Ex. 243	D-1	379	E-3	414	Pellet P243	414
Ex. 244	D-1	379	E-4	416	Pellet P244	416
Ex. 245	D-1	379	E-5	419	Pellet P245	419
Ex. 246	D-1	379	E-6	413	Pellet P246	413
Ex. 247	D-1	379	E-7	414	Pellet P247	414
Ex. 248	D-1	379	E-8	415	Pellet P248	415
Ex. 249	D-1	379	E-9	415	Pellet P249	415
Ex. 250	D-1	379	E-10	416	Pellet P250	416
Ex. 251	D-2	379	E-1	415	Pellet P251	415
Ex. 252	D-2	379	E-2	415	Pellet P252	415
Ex. 253	D-2	379	E-3	414	Pellet P253	414
Ex. 254	D-2	379	E-4	416	Pellet P254	416
Ex. 255	D-2	379	E-5	419	Pellet P255	419
Ex. 256	D-2	379	E-6	413	Pellet P256	413
Ex. 257	D-2	379	E-7	414	Pellet P257	414
Ex. 258	D-2	379	E-8	415	Pellet P258	415
Ex. 259	D-2	379	E-9	415	Pellet P259	415
Ex. 260	D-2	379	E-10	416	Pellet P260	416
Ex. 261	D-3	380	E-1	415	Pellet P261	415
Ex. 262	D-3	380	E-2	415	Pellet P262	415
Ex. 263	D-3	380	E-3	414	Pellet P263	414
Ex. 264	D-3	380	E-4	416	Pellet P264	416
Ex. 265	D-3	380	E-5	419	Pellet P265	419
Ex. 266	D-3	380	E-6	413	Pellet P266	413

(continued)

	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)	Sample	Max. Emission Wavelength (λ_{max}, nm)
Ex. 267	D-3	380	E-7	414	Pellet P267	414
Ex. 268	D-3	380	E-8	415	Pellet P268	415
Ex. 269	D-3	380	E-9	415	Pellet P269	415
Ex. 270	D-3	380	E-10	416	Pellet P270	416
Ex. 271	D-4	381	E-1	415	Pellet P271	415
Ex. 272	D-4	381	E-2	415	Pellet P272	415
Ex. 273	D-4	381	E-3	414	Pellet P273	414
Ex. 274	D-4	381	E-4	416	Pellet P274	416
Ex. 275	D-4	381	E-5	419	Pellet P275	419
Ex. 276	D-4	381	E-6	413	Pellet P276	413
Ex. 277	D-4	381	E-7	414	Pellet P277	414
Ex. 278	D-4	381	E-8	415	Pellet P278	415
Ex. 279	D-4	381	E-9	415	Pellet P279	415
Ex. 280	D-4	381	E-10	416	Pellet P280	416
C. Ex. 1	A-1	380	E-1	415	Simple mixture comA	415

[0337] As shown in Table 1, it was confirmed that pellets P1 to P280 (Examples 1 to 280) according to the present invention had the same maximum emission wavelength as the relatively longer wavelength compound compared to each raw material compound (compounds A-1 to D-4 and compounds E-1 to E-10).

[EXPERIMENTAL EXAMPLE 2] - Performance Evaluation of Organic EL Devices

[0338] The green organic EL devices fabricated in Examples 1 to 280 and Comparative Example 1 were measured for driving voltage, current efficiency, and lifetime T97 at a current density of 10 mA/cm^2. The results are summarized in Table 2.

TABLE 2

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 1	A-1	E-1	Pellet P1	3.45	515	141.4	401
Ex. 2	A-1	E-2	Pellet P2	3.84	516	144.2	402
Ex. 3	A-1	E-3	Pellet P3	3.45	518	146.1	392
Ex. 4	A-1	E-4	Pellet P4	3.54	518	144.3	399
Ex. 5	A-1	E-5	Pellet P5	3.65	518	145.1	391
Ex. 6	A-1	E-6	Pellet P6	3.45	517	145.4	403
Ex. 7	A-1	E-7	Pellet P7	3.56	515	144.2	412
Ex. 8	A-1	E-8	Pellet P8	3.67	518	146.1	421
Ex. 9	A-1	E-9	Pellet P9	3.54	518	144.3	391
Ex. 10	A-1	E-10	Pellet P10	3.56	517	145.1	404
Ex. 11	A-2	E-1	Pellet P11	3.45	515	141.4	401

(continued)

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 12	A-2	E-2	Pellet P12	3.52	516	144.3	370
Ex. 13	A-2	E-3	Pellet P13	3.54	518	144.3	399
Ex. 14	A-2	E-4	Pellet P14	3.65	518	145.1	391
Ex. 15	A-2	E-5	Pellet P15	3.45	517	145.4	403
Ex. 16	A-2	E-6	Pellet P16	3.56	515	144.2	412
Ex. 17	A-2	E-7	Pellet P17	3.67	518	146.1	421
Ex. 18	A-2	E-8	Pellet P18	3.54	518	144.3	391
Ex. 19	A-2	E-9	Pellet P19	3.45	517	145.4	403
Ex. 20	A-2	E-10	Pellet P20	3.56	515	144.2	412
Ex. 21	A-3	E-1	Pellet P21	3.67	518	146.1	421
Ex. 22	A-3	E-2	Pellet P22	3.81	516	142.3	380
Ex. 23	A-3	E-3	Pellet P23	3.54	515	144.2	391
Ex. 24	A-3	E-4	Pellet P24	3.65	518	146.1	403
Ex. 25	A-3	E-5	Pellet P25	3.55	518	144.3	412
Ex. 26	A-3	E-6	Pellet P26	3.65	518	141.4	391
Ex. 27	A-3	E-7	Pellet P27	3.48	517	145.4	403
Ex. 28	A-3	E-8	Pellet P28	3.56	517	144.2	412
Ex. 29	A-3	E-9	Pellet P29	3.84	515	146.1	421
Ex. 30	A-3	E-10	Pellet P30	3.45	518	144.3	391
Ex. 31	A-4	E-1	Pellet P31	3.48	517	144.2	391
Ex. 32	A-4	E-2	Pellet P32	3.67	517	142.3	391
Ex. 33	A-4	E-3	Pellet P33	3.54	515	144.3	404
Ex. 34	A-4	E-4	Pellet P34	3.45	518	142.3	374
Ex. 35	A-4	E-5	Pellet P35	3.54	518	145.4	390
Ex. 36	A-4	E-6	Pellet P36	3.65	518	146.1	403
Ex. 37	A-4	E-7	Pellet P37	3.48	518	141.4	401
Ex. 38	A-4	E-8	Pellet P38	3.81	516	142.3	380
Ex. 39	A-4	E-9	Pellet P39	3.54	515	144.2	391
Ex. 40	A-4	E-10	Pellet P40	3.65	518	146.1	403
Ex. 41	A-5	E-1	Pellet P41	3.55	518	144.3	412
Ex. 42	A-5	E-2	Pellet P42	3.65	518	141.4	391
Ex. 43	A-5	E-3	Pellet P43	3.48	517	145.4	403
Ex. 44	A-5	E-4	Pellet P44	3.56	517	144.2	412
Ex. 45	A-5	E-5	Pellet P45	3.45	517	145.4	403
Ex. 46	A-5	E-6	Pellet P46	3.56	515	144.2	412
Ex. 47	A-5	E-7	Pellet P47	3.67	518	146.1	421
Ex. 48	A-5	E-8	Pellet P48	3.81	516	142.3	380
Ex. 49	A-5	E-9	Pellet P49	3.54	515	144.2	391

(continued)

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 50	A-5	E-10	Pellet P50	3.65	518	146.1	403
Ex. 51	A-6	E-1	Pellet P51	3.55	518	144.3	412
Ex. 52	A-6	E-2	Pellet P52	3.65	518	141.4	391
Ex. 53	A-6	E-3	Pellet P53	3.48	517	145.4	403
Ex. 54	A-6	E-4	Pellet P54	3.56	517	144.2	412
Ex. 55	A-6	E-5	Pellet P55	3.84	515	146.1	421
Ex. 56	A-6	E-6	Pellet P56	3.45	518	144.3	391
Ex. 57	A-6	E-7	Pellet P57	3.48	517	144.2	391
Ex. 58	A-6	E-8	Pellet P58	3.67	517	142.3	391
Ex. 59	A-6	E-9	Pellet P59	3.54	515	144.3	404
Ex. 60	A-6	E-10	Pellet P60	3.45	518	142.3	374
Ex. 61	A-7	E-1	Pellet P61	3.48	517	144.2	391
Ex. 62	A-7	E-2	Pellet P62	3.65	518	142.4	411
Ex. 63	A-7	E-3	Pellet P63	3.55	515	144.3	404
Ex. 64	A-7	E-4	Pellet P64	3.81	518	142.3	374
Ex. 65	A-7	E-5	Pellet P65	3.56	518	145.4	390
Ex. 66	A-7	E-6	Pellet P66	3.58	518	146.1	403
Ex. 67	A-7	E-7	Pellet P67	3.89	517	144.3	412
Ex. 68	A-7	E-8	Pellet P68	3.65	518	141.4	391
Ex. 69	A-7	E-9	Pellet P69	3.48	517	145.4	403
Ex. 70	A-7	E-10	Pellet P70	3.56	517	144.2	412
Ex. 71	A-8	E-1	Pellet P71	3.84	515	146.1	421
Ex. 72	A-8	E-2	Pellet P72	3.45	518	144.3	391
Ex. 73	A-8	E-3	Pellet P73	3.48	517	144.2	391
Ex. 74	A-8	E-4	Pellet P74	3.56	516	144.3	404
Ex. 75	A-8	E-5	Pellet P75	3.48	516	142.3	401
Ex. 76	A-8	E-6	Pellet P76	3.81	518	142.4	411
Ex. 77	A-8	E-7	Pellet P77	3.54	516	144.2	412
Ex. 78	A-8	E-8	Pellet P78	3.65	515	146.1	421
Ex. 79	A-8	E-9	Pellet P79	3.65	518	141.4	391
Ex. 80	A-8	E-10	Pellet P80	3.54	517	143.1	403
Ex. 81	A-9	E-1	Pellet P81	3.56	515	146.5	412
Ex. 82	A-9	E-2	Pellet P82	3.45	516	141.8	421
Ex. 83	A-9	E-3	Pellet P83	3.52	515	140.7	412
Ex. 84	A-9	E-4	Pellet P84	3.74	516	144.3	421
Ex. 85	A-9	E-5	Pellet P85	3.52	516	141.8	391
Ex. 86	A-9	E-6	Pellet P86	3.74	515	140.7	404
Ex. 87	A-9	E-7	Pellet P87	3.84	518	144.1	401

(continued)

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 88	A-9	E-8	Pellet P88	3.45	518	144.3	370
Ex. 89	A-9	E-9	Pellet P89	3.54	518	142.3	399
Ex. 90	A-9	E-10	Pellet P90	3.65	517	144.3	391
Ex. 91	A-10	E-1	Pellet P91	3.55	517	145.1	403
Ex. 92	A-10	E-2	Pellet P92	3.67	518	144.2	412
Ex. 93	A-10	E-3	Pellet P93	3.54	517	143.1	421
Ex. 94	A-10	E-4	Pellet P94	3.56	515	146.5	412
Ex. 95	A-10	E-5	Pellet P95	3.45	516	141.8	421
Ex. 96	A-10	E-6	Pellet P96	3.52	515	140.7	391
Ex. 97	A-10	E-7	Pellet P97	3.74	516	144.3	404
Ex. 98	A-10	E-8	Pellet P98	3.54	516	142.3	401
Ex. 99	A-10	E-9	Pellet P99	3.65	518	142.4	411
Ex. 100	A-10	E-10	Pellet P100	3.54	518	144.3	399
Ex. 101	A-11	E-1	Pellet P101	3.65	518	145.1	391
Ex. 102	A-11	E-2	Pellet P102	3.55	517	145.4	403
Ex. 103	A-11	E-3	Pellet P103	3.67	515	144.2	412
Ex. 104	A-11	E-4	Pellet P104	3.54	518	146.1	421
Ex. 105	A-11	E-5	Pellet P105	3.56	518	144.3	391
Ex. 106	A-11	E-6	Pellet P106	3.45	517	145.1	404
Ex. 107	A-11	E-7	Pellet P107	3.54	515	141.4	401
Ex. 108	A-11	E-8	Pellet P108	3.52	516	144.3	370
Ex. 109	A-11	E-9	Pellet P109	3.54	518	144.3	399
Ex. 110	A-11	E-10	Pellet P110	3.65	518	145.1	391
Ex. 111	A-12	E-1	Pellet P111	3.45	517	145.4	403
Ex. 112	A-12	E-2	Pellet P112	3.56	515	144.2	412
Ex. 113	A-12	E-3	Pellet P113	3.67	518	146.1	421
Ex. 114	A-12	E-4	Pellet P114	3.54	518	144.3	391
Ex. 115	A-12	E-5	Pellet P115	3.45	517	145.4	403
Ex. 116	A-12	E-6	Pellet P116	3.56	515	144.2	412
Ex. 117	A-12	E-7	Pellet P117	3.67	518	146.1	421
Ex. 118	A-12	E-8	Pellet P118	3.81	518	142.3	380
Ex. 119	A-12	E-9	Pellet P119	3.54	517	144.2	391
Ex. 120	A-12	E-10	Pellet P120	3.65	515	146.1	403
Ex. 121	A-13	E-1	Pellet P121	3.55	516	144.3	412
Ex. 122	A-13	E-2	Pellet P122	3.65	516	141.4	391
Ex. 123	A-13	E-3	Pellet P123	3.55	515	141.8	412
Ex. 124	A-13	E-4	Pellet P124	3.67	518	140.7	421
Ex. 125	A-13	E-5	Pellet P125	3.54	518	144.1	391

(continued)

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 126	A-13	E-6	Pellet P126	3.56	518	144.3	404
Ex. 127	A-13	E-7	Pellet P127	3.45	518	142.3	374
Ex. 128	A-13	E-8	Pellet P128	3.54	517	145.4	390
Ex. 129	A-13	E-9	Pellet P129	3.56	515	144.2	391
Ex. 130	A-13	E-10	Pellet P130	3.45	518	146.1	403
Ex. 131	A-14	E-1	Pellet P131	3.56	518	144.3	412
Ex. 132	A-14	E-2	Pellet P132	3.48	517	145.1	391
Ex. 133	A-14	E-3	Pellet P133	3.48	515	141.4	403
Ex. 134	A-14	E-4	Pellet P134	3.81	516	144.3	412
Ex. 135	A-14	E-5	Pellet P135	3.65	518	145.1	391
Ex. 136	A-14	E-6	Pellet P136	3.45	517	145.4	403
Ex. 137	A-14	E-7	Pellet P137	3.56	515	144.2	412
Ex. 138	A-14	E-8	Pellet P138	3.67	518	146.1	421
Ex. 139	A-14	E-9	Pellet P139	3.54	518	144.3	391
Ex. 140	A-14	E-10	Pellet P140	3.45	517	145.4	403
Ex. 141	A-15	E-1	Pellet P141	3.56	515	144.2	412
Ex. 142	A-15	E-2	Pellet P142	3.67	518	146.1	421
Ex. 143	A-15	E-3	Pellet P143	3.54	518	145.4	390
Ex. 144	A-15	E-4	Pellet P144	3.56	518	144.2	391
Ex. 145	A-15	E-5	Pellet P145	3.45	518	146.1	403
Ex. 146	A-15	E-6	Pellet P146	3.56	518	144.3	412
Ex. 147	A-15	E-7	Pellet P147	3.48	517	145.1	391
Ex. 148	A-15	E-8	Pellet P148	3.48	515	141.4	403
Ex. 149	A-15	E-9	Pellet P149	3.81	516	144.3	412
Ex. 150	A-15	E-10	Pellet P150	3.54	516	142.3	421
Ex. 151	A-16	E-1	Pellet P151	3.65	518	142.3	391
Ex. 152	A-16	E-2	Pellet P152	3.56	518	144.3	404
Ex. 153	A-16	E-3	Pellet P153	3.45	518	142.3	374
Ex. 154	A-16	E-4	Pellet P154	3.54	517	145.4	390
Ex. 155	A-16	E-5	Pellet P155	3.56	515	144.2	391
Ex. 156	A-16	E-6	Pellet P156	3.45	518	146.1	403
Ex. 157	A-16	E-7	Pellet P157	3.56	518	144.3	412
Ex. 158	A-16	E-8	Pellet P158	3.48	517	145.1	391
Ex. 159	A-16	E-9	Pellet P159	3.48	515	141.4	403
Ex. 160	A-16	E-10	Pellet P160	3.81	516	144.3	412
Ex. 161	B-1	E-1	Pellet P161	3.55	516	141.8	412
Ex. 162	B-1	E-2	Pellet P162	3.67	515	140.7	421
Ex. 163	B-1	E-3	Pellet P163	3.54	518	145.4	391

(continued)

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 164	B-1	E-4	Pellet P164	3.56	518	144.2	404
Ex. 165	B-1	E-5	Pellet P165	3.45	518	146.1	374
Ex. 166	B-1	E-6	Pellet P166	3.54	517	144.3	390
Ex. 167	B-1	E-7	Pellet P167	3.56	515	145.1	391
Ex. 168	B-1	E-8	Pellet P168	3.45	518	141.4	391
Ex. 169	B-1	E-9	Pellet P169	3.56	518	144.3	403
Ex. 170	B-1	E-10	Pellet P170	3.48	517	142.3	412
Ex. 171	B-2	E-1	Pellet P171	3.48	515	141.4	404
Ex. 172	B-2	E-2	Pellet P172	3.81	516	144.3	374
Ex. 173	B-2	E-3	Pellet P173	3.54	516	142.3	390
Ex. 174	B-2	E-4	Pellet P174	3.65	518	146.1	401
Ex. 175	B-2	E-5	Pellet P175	3.81	516	144.3	411
Ex. 176	B-2	E-6	Pellet P176	3.54	516	142.3	412
Ex. 177	B-2	E-7	Pellet P177	3.65	518	142.3	391
Ex. 178	B-2	E-8	Pellet P178	3.56	518	144.3	404
Ex. 179	B-2	E-9	Pellet P179	3.45	518	142.3	374
Ex. 180	B-2	E-10	Pellet P180	3.54	517	145.4	390
Ex. 181	B-3	E-1	Pellet P181	3.56	515	144.2	391
Ex. 182	B-3	E-2	Pellet P182	3.52	516	141.8	370
Ex. 183	B-3	E-3	Pellet P183	3.74	515	140.7	380
Ex. 184	B-3	E-4	Pellet P184	3.84	518	144.1	385
Ex. 185	B-3	E-5	Pellet P185	3.45	518	144.3	404
Ex. 186	B-3	E-6	Pellet P186	3.54	518	142.3	374
Ex. 187	B-3	E-7	Pellet P187	3.65	517	144.3	390
Ex. 188	B-3	E-8	Pellet P188	3.55	517	145.1	421
Ex. 189	B-3	E-9	Pellet P189	3.67	518	144.2	391
Ex. 190	B-3	E-10	Pellet P190	3.54	517	143.1	403
Ex. 191	B-4	E-1	Pellet P191	3.56	515	146.5	412
Ex. 192	B-4	E-2	Pellet P192	3.45	516	141.8	421
Ex. 193	B-4	E-3	Pellet P193	3.52	515	140.7	391
Ex. 194	B-4	E-4	Pellet P194	3.74	516	144.3	404
Ex. 195	B-4	E-5	Pellet P195	3.54	516	142.3	401
Ex. 196	B-4	E-6	Pellet P196	3.65	518	142.4	411
Ex. 197	B-4	E-7	Pellet P197	3.55	516	144.2	412
Ex. 198	B-4	E-8	Pellet P198	3.67	515	146.1	421
Ex. 199	B-4	E-9	Pellet P199	3.54	518	144.3	391
Ex. 200	B-4	E-10	Pellet P200	3.56	516	141.2	390
Ex. 201	C-1	E-1	Pellet P201	3.45	518	142.3	374

(continued)

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 202	C-1	E-2	Pellet P202	3.54	517	145.4	404
Ex. 203	C-1	E-3	Pellet P203	3.56	515	144.2	374
Ex. 204	C-1	E-4	Pellet P204	3.45	518	146.1	390
Ex. 205	C-1	E-5	Pellet P205	3.56	518	144.3	412
Ex. 206	C-1	E-6	Pellet P206	3.48	517	145.1	391
Ex. 207	C-1	E-7	Pellet P207	3.48	515	141.4	403
Ex. 208	C-1	E-8	Pellet P208	3.54	518	142.3	391
Ex. 209	C-1	E-9	Pellet P209	3.65	517	144.3	412
Ex. 210	C-1	E-10	Pellet P210	3.55	517	145.1	421
Ex. 211	C-2	E-1	Pellet P211	3.67	518	144.2	391
Ex. 212	C-2	E-2	Pellet P212	3.54	517	143.1	404
Ex. 213	C-2	E-3	Pellet P213	3.56	515	146.5	401
Ex. 214	C-2	E-4	Pellet P214	3.45	516	141.8	411
Ex. 215	C-2	E-5	Pellet P215	3.52	515	140.7	374
Ex. 216	C-2	E-6	Pellet P216	3.74	516	144.3	390
Ex. 217	C-2	E-7	Pellet P217	3.54	516	142.3	374
Ex. 218	C-2	E-8	Pellet P218	3.65	518	142.4	390
Ex. 219	C-2	E-9	Pellet P219	3.81	516	144.3	391
Ex. 220	C-2	E-10	Pellet P220	3.55	516	141.8	403
Ex. 221	C-3	E-1	Pellet P221	3.67	515	140.7	412
Ex. 222	C-3	E-2	Pellet P222	3.54	518	144.1	391
Ex. 223	C-3	E-3	Pellet P223	3.56	518	144.3	404
Ex. 224	C-3	E-4	Pellet P224	3.45	518	142.3	374
Ex. 225	C-3	E-5	Pellet P225	3.54	517	145.4	390
Ex. 226	C-3	E-6	Pellet P226	3.56	515	144.2	391
Ex. 227	C-3	E-7	Pellet P227	3.45	518	146.1	403
Ex. 228	C-3	E-8	Pellet P228	3.56	518	144.3	412
Ex. 229	C-3	E-9	Pellet P229	3.48	517	145.1	391
Ex. 230	C-3	E-10	Pellet P230	3.48	515	141.4	403
Ex. 231	C-4	E-1	Pellet P231	3.81	516	144.3	412
Ex. 232	C-4	E-2	Pellet P232	3.54	516	142.3	421
Ex. 233	C-4	E-3	Pellet P233	3.65	518	142.3	391
Ex. 234	C-4	E-4	Pellet P234	3.55	517	145.4	404
Ex. 235	C-4	E-5	Pellet P235	3.67	515	144.2	401
Ex. 236	C-4	E-6	Pellet P236	3.54	518	146.1	411
Ex. 237	C-4	E-7	Pellet P237	3.45	518	144.3	374
Ex. 238	C-4	E-8	Pellet P238	3.54	517	145.1	390
Ex. 239	C-4	E-9	Pellet P239	3.45	518	142.3	374

(continued)

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 240	C-4	E-10	Pellet P240	3.54	517	145.4	390
Ex. 241	D-1	E-1	Pellet P241	3.56	515	144.2	391
Ex. 242	D-1	E-2	Pellet P242	3.45	518	146.1	403
Ex. 243	D-1	E-3	Pellet P243	3.56	518	144.3	412
Ex. 244	D-1	E-4	Pellet P244	3.48	517	145.1	391
Ex. 245	D-1	E-5	Pellet P245	3.48	515	141.4	403
Ex. 246	D-1	E-6	Pellet P246	3.81	516	144.3	412
Ex. 247	D-1	E-7	Pellet P247	3.54	516	142.3	421
Ex. 248	D-1	E-8	Pellet P248	3.65	518	142.3	391
Ex. 249	D-1	E-9	Pellet P249	3.45	518	142.3	374
Ex. 250	D-1	E-10	Pellet P250	3.54	517	145.4	390
Ex. 251	D-2	E-1	Pellet P251	3.56	515	144.2	391
Ex. 252	D-2	E-2	Pellet P252	3.45	518	146.1	403
Ex. 253	D-2	E-3	Pellet P253	3.56	518	144.3	412
Ex. 254	D-2	E-4	Pellet P254	3.48	517	145.1	391
Ex. 255	D-2	E-5	Pellet P255	3.48	515	141.4	403
Ex. 256	D-2	E-6	Pellet P256	3.81	516	144.3	412
Ex. 257	D-2	E-7	Pellet P257	3.54	516	142.3	421
Ex. 258	D-2	E-8	Pellet P258	3.65	518	142.3	391
Ex. 259	D-2	E-9	Pellet P259	3.55	517	145.4	404
Ex. 260	D-2	E-10	Pellet P260	3.67	515	144.2	401
Ex. 261	D-3	E-1	Pellet P261	3.54	518	142.3	411
Ex. 262	D-3	E-2	Pellet P262	3.45	518	142.3	374
Ex. 263	D-3	E-3	Pellet P263	3.54	517	145.4	390
Ex. 264	D-3	E-4	Pellet P264	3.56	515	144.2	391
Ex. 265	D-3	E-5	Pellet P265	3.45	518	146.1	403
Ex. 266	D-3	E-6	Pellet P266	3.56	517	144.3	412
Ex. 267	D-3	E-7	Pellet P267	3.48	515	145.1	391
Ex. 268	D-3	E-8	Pellet P268	3.48	518	145.1	403
Ex. 269	D-3	E-9	Pellet P269	3.81	518	141.4	412
Ex. 270	D-3	E-10	Pellet P270	3.56	517	144.3	421
Ex. 271	D-4	E-1	Pellet P271	3.45	517	142.3	411
Ex. 272	D-4	E-2	Pellet P272	3.56	515	145.4	374
Ex. 273	D-4	E-3	Pellet P273	3.48	515	144.2	390
Ex. 274	D-4	E-4	Pellet P274	3.48	518	146.1	412
Ex. 275	D-4	E-5	Pellet P275	3.81	518	144.3	391
Ex. 276	D-4	E-6	Pellet P276	3.54	517	145.1	403
Ex. 277	D-4	E-7	Pellet P277	3.48	517	145.1	412

(continued)

Sample	Material of Pellet		Host	Driving Volt. V)	EL Peak (nm)	Current Effici. (cd/A)	Lifespan (hr, T_{97})
	1st Organic Cpd.	2nd Organic Cpd.					
Ex. 278	D-4	E-8	Pellet P278	3.48	515	141.4	421
Ex. 279	D-4	E-9	Pellet P279	3.81	516	144.3	411
Ex. 280	D-4	E-10	Pellet P280	3.56	516	142.3	374
C. Ex. 1	A-1	E-1	Simple mixture comA	4.31	515	121.4	150

[0339] As shown in Table 2, the green organic EL device of Example 1, using Pellet P1 as the host material for the emission layer, exhibited a lower driving voltage, higher current efficiency, and longer lifespan compared to the green organic EL device of Comparative Example 1, which used the simple mixture comA. This indicates that the use of the pellet according to the present invention as a material for the organic layer (e.g., the host material for the emission layer) in OLEDs can improve the performance of the organic EL device.

[EXPERIMENTAL EXAMPLE 3]

[0340] In Examples 1, 281 to 282, and Comparative Examples 1 to 3, when green organic EL devices were fabricated, thin films were formed through a continuous process. The weight ratio changes of compounds A-1 and E-1 in pellets P1, P281 to P282, and simple mixtures comA to comC before and after the process were measured. The results are summarized in Table 3.

TABLE 3

Sample	Pre-Process		Post-Process		Temporal change (%)
	Cpd. A-1 (Wt. ratio)	Cpd. E-1 (Wt. ratio)	Cpd. A-1 (Wt. ratio)	Cpd. E-1 (Wt. ratio)	
Ex. 1 (Pellet P1)	60	40	59.8	40.2	0.2
Ex. 281 (Pellet P281)	50	50	50.1	49.9	0.1
Ex. 282 (Pellet P282)	70	30	70.1	29.9	0.1
C. Ex. 1 (Simple mixture comA)	60	40	54.1	45.9	5.9
C. Ex. 2 (Simple mixture comB)	50	50	42.8	57.2	7.2
C. Ex. 3 (Simple mixture comC)	70	30	63.4	36.6	6.6

[0341] As shown in Table 3, it was confirmed that when the emission layer thin film of the green organic EL device was formed using pellets P1, P281, and P282 (Examples 1, 281 to 282) through a continuous process, the thin film was reproducibly and consistently formed, compared to when the emission layer thin film of the green organic EL device was formed using the simple mixtures of compounds A-1 and E-1 (Comparative Examples 1 to 3) through a continuous process.

Claims

1. A pellet for an organic electroluminescent device, comprising two or more types of organic compound powders, including a first organic compound powder and a second organic compound powder that have been compressed, wherein the pellet has the same maximum emission wavelength as the organic compound with a longer emission wavelength among the first organic compound and the second organic compound.

2. The pellet of claim 1, wherein the pellet has the same maximum emission wavelength as the mixture of the first organic

compound powder and the second organic compound powder.

3. The pellet of claim 1, wherein the pellet comprises:

   a first region having a first organic compound powder compressed therein, and
   a second region having second organic compound powder compressed therein and integrated with the first region.

4. The pellet of claim 1, wherein the first region and the second region are alternately arranged in a radial direction from the center outward.

5. The pellet of claim 3, wherein the first region and the second region are arranged in a longitudinal direction.

6. The pellet of claim 5, wherein the first region and the second region are arranged in an alternating pattern.

7. The pellet of claim 3, wherein the first region and the second region are alternately arranged in a circumferential direction.

8. The pellet of claim 7, wherein the first region and the second region are alternately arranged in an upper and lower configuration.

9. The pellet of claim 3, wherein the pellet has a shape selected from the group consisting of polyhedral, cylindrical, and spherical shapes.

10. The pellet of claim 1, wherein the first organic compound powder and the second organic compound powder are contained at a weight ratio of 1:99 to 99:1.

11. The pellet of claim 1, wherein both the first organic compound powder and the second organic compound powder are sublimable powders.

12. The pellet of claim 1, wherein

    the first organic compound is a hole-transporting organic compound; and
    the second organic compound is an electron-transporting organic compound.

13. The pellet of claim 12, wherein the hole-transporting organic compound is a hole-transporting host.

14. The pellet of claim 12, wherein the hole-transporting host is a carbazole-based compound.

15. The pellet of claim 12, wherein the electron-transporting organic compound is an electron-transporting host.

16. The pellet of claim 15, wherein the electron-transporting host is an azine-based compound.

17. The pellet of claim 1, wherein the two or more types of organic compound powders are injection molded into the pellet without heat treatment while a pressure of 20,000-40,000 kgf/cm^2 is applied thereto.

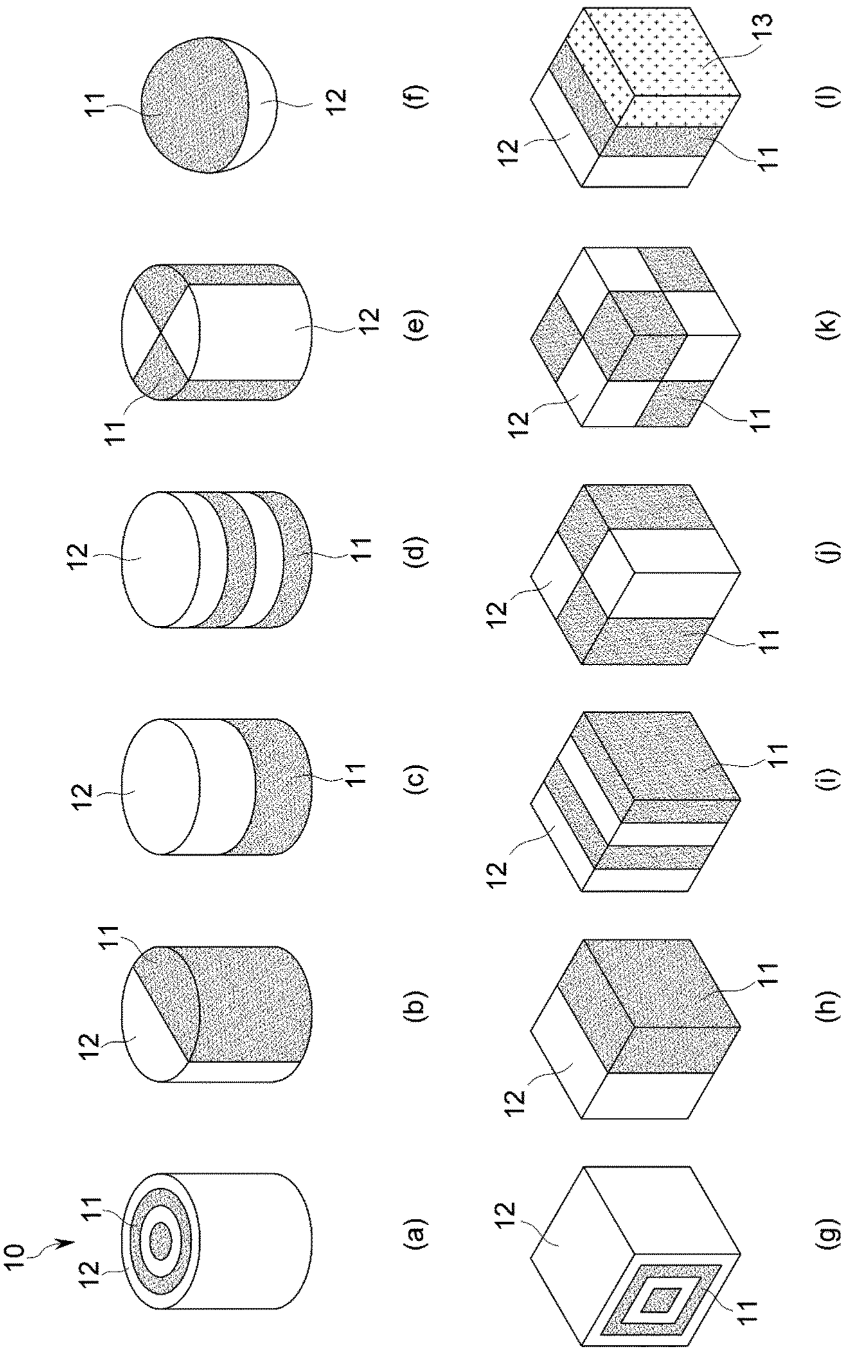
18. The pellet of claim 1, wherein the first organic compound powder and the second organic compound powder have a deposition temperature difference of 0 to 30°C under a pressure of 10^{-6} torr.

19. The pellet of claim 1, wherein the pellet has a BET specific surface area smaller than that of the simple mixture of the first and second organic compound powders.

20. The pellet of claim 1, wherein the pellet has a surface resistance smaller than that of the simple mixture of the first and second organic compound powders.

21. An organic electroluminescent device, comprising: an anode; a cathode; and at least one organic layer interposed between the anode and cathode, wherein at least one of the organic layers is a homogeneous thin film containing the first and second organic compounds formed using the pellet of any one of claims 1 to 20.

[FIG. 1]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(b)
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(c)
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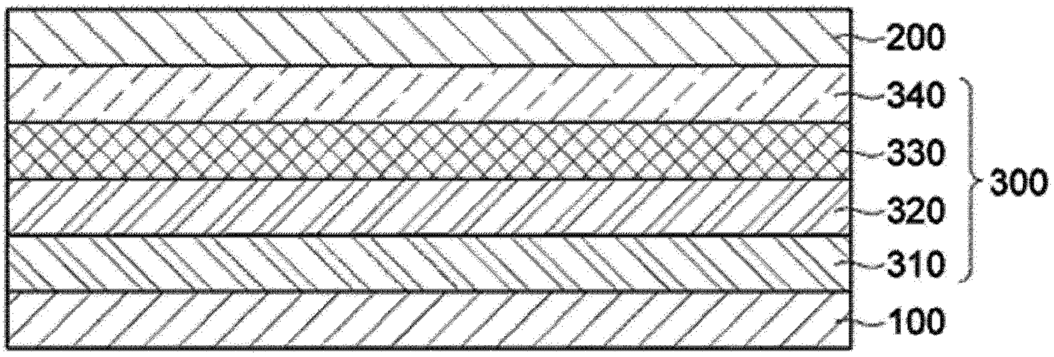
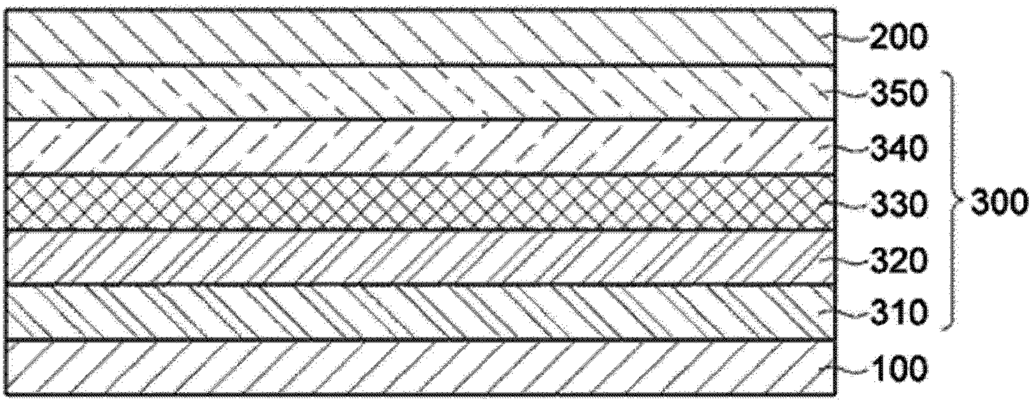
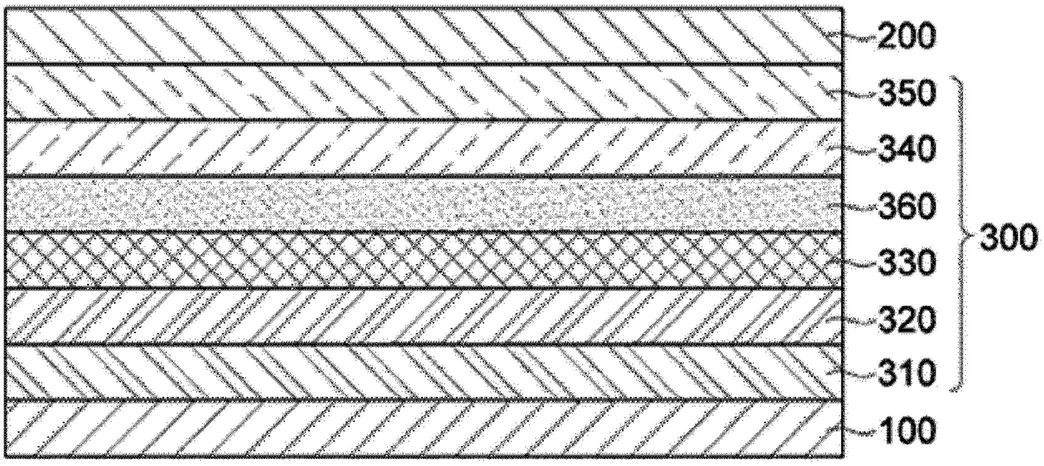
[FIG. 2]



[FIG. 3]



[FIG. 4]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2023/008131

A. CLASSIFICATION OF SUBJECT MATTER

H10K 50/11(2023.01)i; **H10K 50/15**(2023.01)i; **H10K 50/16**(2023.01)i; **H10K 85/60**(2023.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H10K 50/11(2023.01); C09K 11/06(2006.01); C23C 14/12(2006.01); H01L 51/00(2006.01); H01L 51/50(2006.01); H05B 33/10(2006.01); H10K 50/00(2023.01); H10K 99/00(2023.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 유기전계발광소자(organic electroluminescent device), 유기 화합물(organic compound), 발광 파장(light emission wavelength), 펠릿(pellet)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2020-143169 A (IDEMITSU KOSAN CO., LTD.) 10 September 2020 (2020-09-10) See paragraphs [0024]-[0025], [0063]-[0069], [0096]-[0100] and [0103]-[0106].	1-2,10-21 3-9
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☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search **20 September 2023**	Date of mailing of the international search report **21 September 2023**
Name and mailing address of the ISA/KR **Korean Intellectual Property Office** **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208** Facsimile No. **+82-42-481-8578**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2023/008131

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2023/008131

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Form PCT/ISA/210 (patent family annex) (July 2022)